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AMERICAN DYESTUFF REPORTER

EBRUARY 1, 1943
OLUME 32, No. 3

OFFICIAL PUBLICATION
of the
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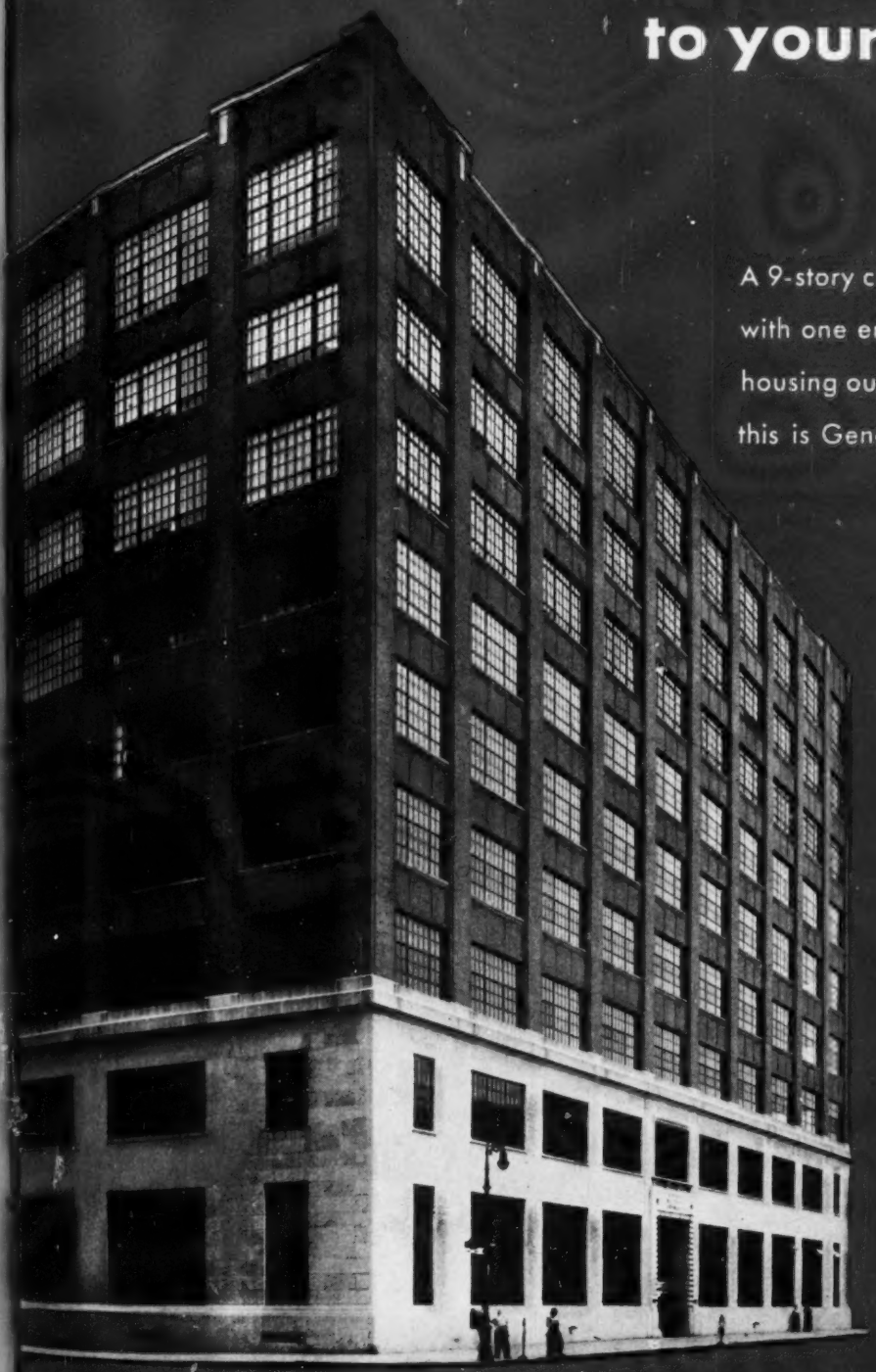

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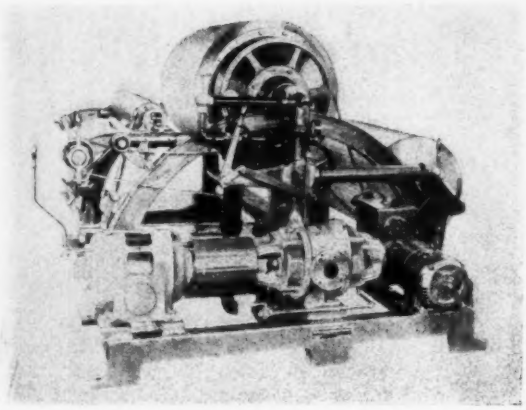

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NOT ONE, NOT TWO, BUT

3

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1 Technically correct pigmented colors
2 Proper application to the fibers
3 Adequate curing of the fabric

NO SHORTCUT PROCEDURE CAN PRODUCE A SATISFACTORY BOND

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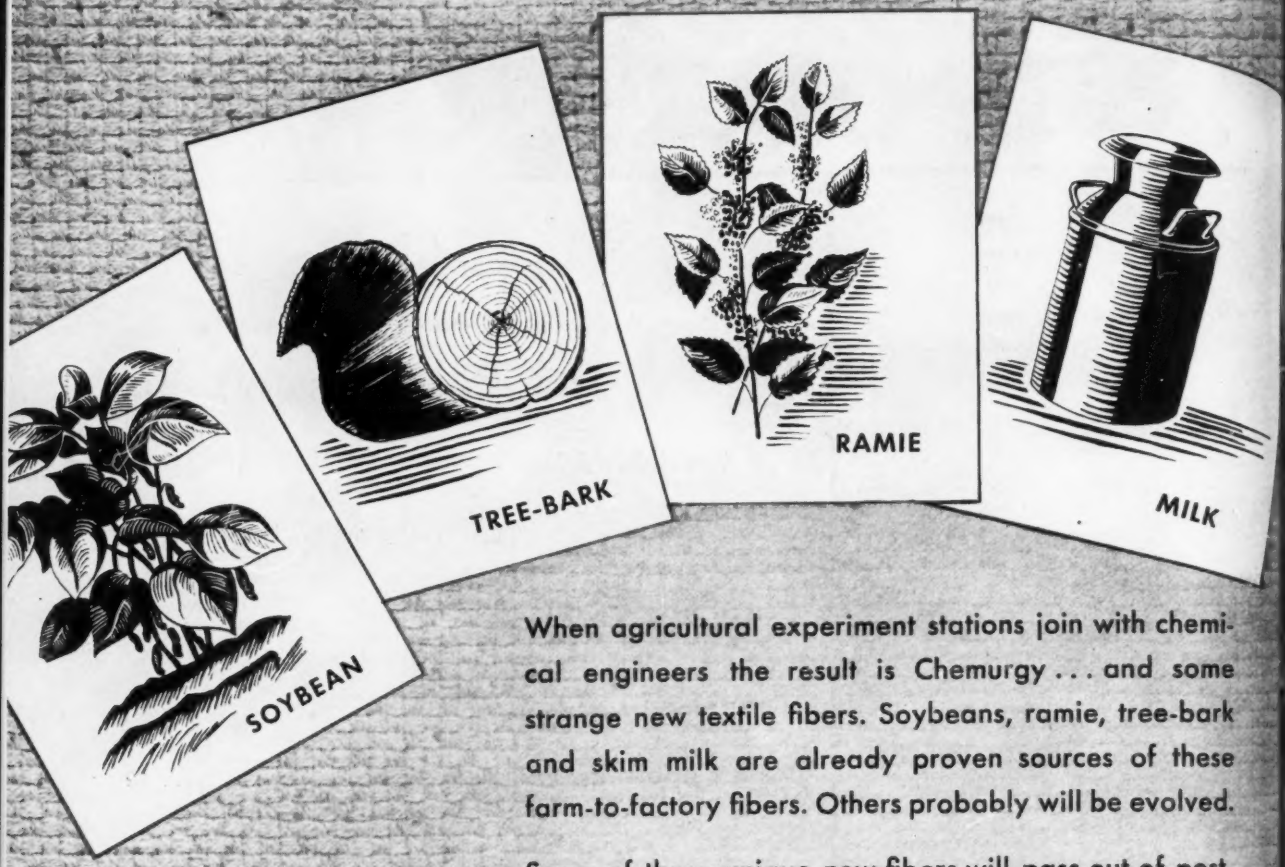
THE FUTURE OF FARM-TO-FACTORY FIBERS



When agricultural experiment stations join with chemical engineers the result is Chemurgy . . . and some strange new textile fibers. Soybeans, ramie, tree-bark and skim milk are already proven sources of these farm-to-factory fibers. Others probably will be evolved.

Some of these unique new fibers will pass out of post-war markets, while others will find an economic place in specialized textiles. All will complicate the problems of the dyehouse.

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AMERICAN
DYESTUFF REPORTER

VOLUME 32 FEBRUARY 1, 1943 NUMBER 3

The Chemical Constitution of the CHROME AZO DYES

KENNETH L. DORMAN*

I. INTRODUCTION

THIS paper is written in an attempt to clarify the chemical constitution of the so-called "chrome colors," and in particular, that of the chrome azo colors. Both the layman and dyestuff technician may obtain a better picture of this very important class of coloring matters. Perhaps in a small way this article may be of technical value to those engaged in the production and use of these dyestuffs for our war effort.

Greater and greater is the use of the chrome azo colors both for civilian and more especially for military purposes. An example of this is the use of the chrome color Alizarin Yellow 2G (C.I. 36), made from meta nitro aniline and salicylic acid. At this immediate time is seen with the chrome azo colors the greatest usage of any type of azo dyes—for dyeing army cloths. The chrome dyes possibly surpass in this respect the vat dyes which are more difficult to make and whose intermediates are much harder to secure.

The army, navy, and air forces of America have in the past principally used but three classes of dyestuffs, namely, vat, chrome and mineral dyes. The key to this may be found in the fastness requirements. The employment of sulfur dyes has been frowned upon, due largely to tendering action and general non-fastness to chlorine of the sulfur dyes. Tendering of sulfur dyed goods was experienced in the last war.

All the chrome dyes can be applied to woolen goods; in fact this type of fabric is the forte of the chrome dyes. The mineral dyed fabrics are also in great use. There is one new process for the dyeing of military fabrics which we now have, namely the pigment pad method, using pigmented emulsions. The pigments may be organic or inorganic. The emulsions may be water in oil or oil in water type, depending on the conditions encountered and results desired. This process is rapidly growing in scope and is a valuable adjunct to the too few satisfactory procedures adaptable for the coloring of textile fibers and fabrics intended for military use. It is also used for coloring work-clothes for mechanics and munitions workers.

In respect to the use of vat dyes on woolen cloths, care must be exercised in the use of caustic and hydro employed to reduce these vats to their leuco compounds. Excess of caustic renders wool harsh as well as tendering it. Many plants replace caustic by the not too easily obtained ammonia for dyeing wool with certain vats.

The chrome dyes on the other hand can be applied from an acid bath, many being applied in the same way as direct acid wool dyes. The chrome dyes can be applied "bottom chrome," "meta chrome," or "top chrome," signifying respectively, chroming before, during, or after dyeing. A special class of metachrome colors are the Neolan and Palatine Dyes which are bought as dyes already having chrome in their molecule, and needing no further chrome additions before, with, or after dyeing. Very fortunately this last type of chrome dye is sparingly water soluble and is fixed during dyeing.

Chrome colors to the textile chemist and technician are mordant colors, employing chromium as a mordant. The brilliance of the mordant colors runs generally in the following order of mordants: tin, aluminum, chromium, copper, and iron, with the first mentioned the most brilliant. However, the fastness to light runs generally in exactly the opposite order. Chromium in the middle of the list gives good brilliance, good lightfastness, and usually excellent washfastness if applied on a suitable fiber. The fastness of dyes to light, washing, and other tests bears a direct relation to the kind of fiber and method of application thereto. In metallizable pigment colors the divalent metals, particularly copper, seem to work best. The reason why trivalent metals give best results on wool fiber dyes, and the divalent metals give best results in metallized pigments may be seen in the fact that wool fiber contains in its chemical makeup amino and hydroxy groups to supply

* Aridye Corporation, Fairlawn, New Jersey.

the third "base" for the trivalent metal, while with pigments there is usually no "base" for the third valency if a metal such as chromium is used, whereas when a divalent metal such as copper is used, no third "base" is necessary because all the valencies are filled.

Mordant colors are polychromatic, that is, different colors are obtained according to the metal employed. Certain mordant colors may be monochromatic, that is, but one shade being obtained despite varying the metal used as mordant. Slight variations in shade are obtained by the different salts of a given metal employed. This is largely a pH phenomenon.

Mordant colors, chemically speaking, come from several groups. The various chemical families which are susceptible to mordanting include the nitroso (otherwise known as quinoneoxime), triphenylmethane, anthraquinone, and azo classes. The pyrazolones may be considered under the azo class since they are azoic in nature, using a pyrazolone derivative as coupling component.

Certain chemical linkages and groupings endow the dye molecule with the mordanting property. These arrangements are (1) two hydoxyl groups ortho to each other, (2) a hydroxyl group ortho to a carboxyl group, (3) a hydroxyl group ortho to a sulfonic group, (4) an azo group ortho to a hydroxyl group, (5) a hydroxyl group peri to another hydroxyl, carboxyl group, or sulfonic group, (6) a hydroxyl group ortho or peri to an amino group, (7) an azo group ortho to a ketone group—such as a beta diketone, acetoacetester derivative or pyrazolone. There are several other groupings of less importance. The fact that a dye molecule may have one or more of these arrangements does not necessarily mean that the compound will give a good mordant color, but the probabilities are high. A plurality of these groupings enhances the mordant forming properties as well as the various types of fastness derived. If these mordant endowing groups are so situated to coordinate each other the mordanted dye possesses a much higher degree of allround fastness.

In Table I is shown the more important chemical families capable of forming mordant colors as well as a few examples of mordant dyes falling in each class.

Realizing that azo colors are not the only chemical type of dyes capable of mordanting, and that mordanting need not be limited to chromium as the metal, this discussion will be confined to the Chrome Azo Colors since chromium is the metal most commonly employed, and since the author is most familiar with the azo class of metallized colors.

It is also to be noted that in most cases the color of the chromed dye is quite different than that of the unchromed product. For example, para nitraniline coupled to beta oxy naphthoic acid gives a red which is changed into various shades of brown when metallized. In this article the color of the chromed product will be noted in the tables found herein.

Many dyes which are useless because of poor light or

TABLE I

Chemical Families Capable of Mordanting

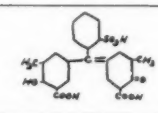
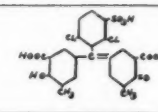
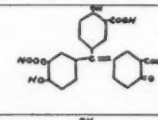
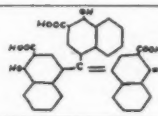
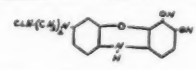
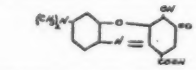
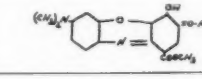
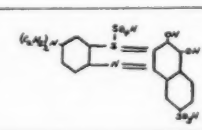
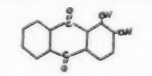
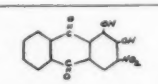
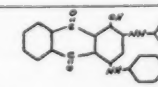
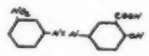
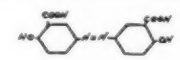
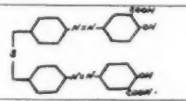
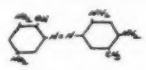
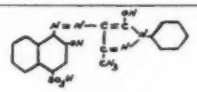
1.	Nitroso or Quinoneoxime Colors		
		Nitroso Compound	Quinoneoxime Comp'd
	Nitroso Resorcinol		
	Alpha Nitroso Beta Naphthol		
	Beta Nitroso Alpha Naphthol		
	Alpha Nitroso 2:7 Dihydroxy-Naphthalene		
2.	Triphenylmethane Colors		
	C.I.722 Schultz 840		
	C.I.723 Schultz 841		
	C.I.727 Schultz 846		
	Schultz 852		
3.	Oxazine Colors		
	C.I.881 Schultz 996		
	C.I.883 Schultz 998		
	C.I.893 Schultz 1006		
4.	Thiazine Colors		
	C.I.930 Schultz 1047		
5.	Hydroquinone and Ketone Colors (Anthraquinones)		
	Alizarin		
	Nitroalizarin		
	C.I.1085 Schultz 1195		

TABLE I (Cont.)

6.	Azo Colors (Including Pyrazolone Colors)	
	C.I.36 Schultz 55	
	C.I.219 Schultz 258	
	C.I.343 Schultz 330	
	C.I.101 Schultz 136	
	C.I.652 Schultz 742	

wash fastness are rendered fast by being metallized. The tinctorial value is improved and the shade in most cases is deepened.

II. CHROME AZO DYES

The chrome azo dyes can be split into several classifications. These include the so called salicylic acid dyes which include the misnamed "alizarin yellows" made from the nitranilines and salicylic acid, and the "diamond yellows" made from the amino benzoic acids and salicylic acid. The salicylic acid dyes are not fast to potting. The "alizarin yellows" which are not derivatives of anthraquinone or alizarine, are also called the "Nitraniline Dyes."

A second classification includes the ortho hydroxy or O:O′ dihydroxy dyes made from ortho amino phenols or naphthols coupled with naphthols or amines.

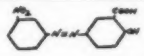
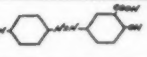
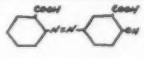
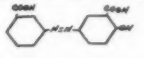
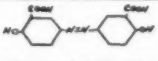
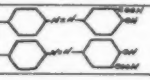
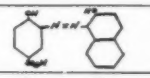
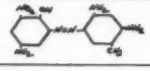
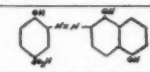
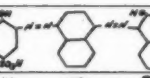
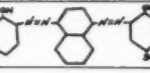
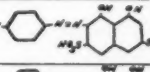
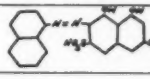
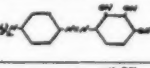
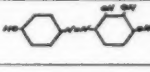
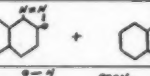
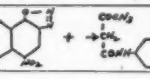
The third group is the naphthalene O-hydroxy dyes sometimes called the O:P:O′ trihydroxy dyes made from dihydroxy naphthalenes coupled with amino phenols or amino naphthols or their derivatives. Diamond Black PV falls in this class.

The non adjacent O:O′ dihydroxy dyes which have outstanding fastness and are in greatest demand for chrome black shades form the fourth group. These are made from an amino phenol or naphthol coupled to an alpha naphthylamine derivative and thence to a naphthol. Hence these dyes are secondary disazo dyes. An exception is the primary disazo dye class made from para phenylene diamine coupled to two similar or different naphthols or phenols. With para phenylene diamine it is necessary to first form the mono acetyl compound, diazotize, couple with one second component, hydrolyze, diazotize the second amino group, and finally couple with the other desired second component. With the alpha naphthylamine type of non adjacent O:O′ dihydroxy dyes the amino phenol or amino naphthol is diazotized, coupled with alpha naphthylamine; this intermediate product is then diazotized and coupled to a naphthol.

The fifth group is made of the "Chromotrope dyes," often called "the Chromotropes." These are formed by coupling amines, ortho amino phenols, or amino naphthols

TABLE II

Chrome Azo Dye Types

I.	Salicylic Acid Dyes	
	Alizarine Yellow GG	
	Alizarine Yellow R	
	Diamond Yellow R	
	Diamond Yellow G	
	Eriochrome Flavine A	
	Anthracene Yellow C	
II.	Ortho Hydroxy(O:O′ Dihydroxy) Dyes	
	Chrome Fast Violet B	
	Metachrome Brown B	
III.	Naphthalene O-Hydroxy(O:P:O′ Trihydroxy) Dyes	
	Diamond Black PV	
IV.	Non-Adjacent O:O′ Dihydroxy Dyes	
	Eriochrome Blue Black G	
	Diamond Black F	
V.	Chromotrope Dyes("The Chromotropes")	
	Chromotrope 2B	
	Chromotrope 10B	
VI.	Pyrogallol Dyes	
	Azogalleine	
	Azochromine	
VII.	Abnormal Chrome Azo Dyes	
	Neolan Blue B	
	Neolan Yellow(GR ?)	

to chromotropic acid or its derivatives. It will be noted that in chromotropic acid the hydroxy groups are in the peri (1:8) position. These dyes are not fast to potting and not a single one is fast to fulling.

The next group is the pyrogallol dyes. These are made by coupling appropriate amines with pyrogallol or pyrogallol derivatives. It will be noted that these are also trihydroxy dyes by reason of the three hydroxy groups of the pyrogallol nucleus.

The last group may be called the abnormal chrome azo dyes. This includes the dyes best known by the trade name "Neolans." This class may be considered as borderline soluble complexes or soluble lakes. None are potting fast but most are fair to good to fulling. Their ease of application makes them one of the most popular types of dyes for the coloring of woolen and worsted goods. It is reported that the Lanasol Dyes are similar to the Neolans but employ copper instead of chromium as the metal.

The above subdivisions of chrome azo dyes are shown in Table II, as well as a few well known examples of each type.

III. CHROME AZO DYESTUFF INTERMEDIATES

In Table III are given the intermediates employed in the manufacture of chrome azo colors. These intermediates are grouped in the following eleven categories:

1. Hydroxy benzene carboxylic acids and their derivatives
2. Amino benzenes and derivatives
3. Phenol derivatives, excepting their carboxylic acid derivatives
4. Polyhydroxy benzenes and naphthalenes and their sulfo acids
5. Alpha and beta naphthols and their sulfonic acids
6. Alpha and beta naphthylamines and their sulfonic acids
7. Amino naphthols and their derivatives
8. Diamino benzenes and derivatives
9. Amino azo benzenes and derivatives
10. Polynuclear diamines and their derivatives
11. Miscellaneous

Under each section are given all the other intermediates used with a given intermediate to produce chrome azo colors. Arrows pointing from an intermediate indicates that the latter was diazotized first and coupled to the intermediate the arrow points at. In the case of polyazo dyes the order of coupling is numerically designated. With each dyestuff produced is given a reference classification to the color of the chromed dyestuff as well as to one of the tables given later below. By referring to Table III and Tables IV through XIII, the raw materials, procedure, and structural formula of a particular chrome azo dyestuff is determined.

TABLE III

Hydroxy Benzene Carboxylic Acids and Derivatives

Salicylic Acid

←Meta Nitro Aniline.....Y-1
←Para Nitro Aniline.....Y-2
←Aniline plus subsequent nitration.....Y-2
←Para Amino Acetanilide.....Y-3
(Acetyl Para Phenylene Diamine)
←Para Toluidine.....Y-4
←Meta Nitro Para Toluidine.....Y-5
←Para Toluidine plus subsequent mono nitration.....Y-5
←Ortho Anisidine.....Y-6
←Para Phenetidine.....Y-7
←Para Nitro Aniline Ortho Sulfonic Acid.....O-1
←Ortho Amino Benzoic Acid (Anthranilic Acid).....Y-8
←Meta Amino Benzoic Acid.....Y-9
←Ortho Chloro Meta Amino Benzoic Acid plus NaOH fusion.....Y-10
←Benzidine plus Sodium Sulfite.....Y-22
←Benzidine plus hydrolysis.....Y-23
←2-Naphthylamine 4-Sulfonic Acid.....Y-11
←2-Naphthylamine 5-Sulfonic Acid.....Y-12
←2-Naphthylamine 6-Sulfonic Acid (Bronner's Acid).....Y-13
←2-Naphthylamine 6:8-Disulfonic Acid (Amino G Acid)..Y-14
←Amino Azo Benzol Para Sulfonic Acid.....O-7
Sulfanilic Acid*
↓
Salicylic Acid.....Br.-23
↑
Para Nitro Aniline

* 1- or 2-Naphthylamine mono sulfonic acid or Amino Azo Benzene sulfo acid may be used in place of Sulfanilic Acid.

Salicylic Acid
↑ (1)
Para Amino Acetanilide; plus hydrolysis (2).....Bdx.-12
↓ (3)
1-Naphthol 4-Sulfonic Acid (NW Acid)

Salicylic Acid
↑ (1)
Para Amino Acetanilide; plus hydrolysis (2).....R-12
↓ (3)
2-Naphthylamine 6-Sulfonic Acid (Bronner's Acid)

Salicylic Acid
↑ (1)
Para Amino Acetanilide; plus hydrolysis (2).....Bk.-26
↓ (3)
1:8-Dihydroxy Naphthalene 3:6-Disulfo Acid (Chromotropic Acid)

Salicylic Acid
↑
Benzidine.....O-4
↓
Resorcinol

Salicylic Acid
↑
Benzidine.....R-13
↓
1-Naphthol 4-Sulfonic Acid (NW Acid)

Salicylic Acid
↑
Benzidine.....O-5
↓
1-Naphthylamine 4-Sulfonic Acid (Naphthionic Acid)

Salicylic Acid
↑
Benzidine.....O-6
↓
2-Naphthylamine 7-Sulfonic Acid

Salicylic Acid
↑
Benzidine.....Y-37
↓
2:7-Dihydroxy Naphthalene

TABLE III (Cont.)

Salicylic Acid
↑
Benzidine R-14
↓
2-Amino 8-Naphthol 6-Sulfonic Acid

Salicylic Acid
↑
Benzidine Br.-25
↓
2-Amino 8-Naphthol 6-Sulfonic Acid

Salicylic Acid
↑
O-Nitro Benzidine; plus sulfonation after coupling..... Y-35
↓
Salicylic Acid

Salicylic Acid
↑
O-Nitro Benzidine; plus sulfonation after coupling..... R-16
↓
Beta Naphthol

Salicylic Acid
↑
O-Nitro Benzidine R-15
↓
1-Naphthol 4-Sulfonic Acid (NW Acid)

Salicylic Acid
↑
Benzidine O:O'-Disulfonic Acid Y-29
↓
Salicylic Acid

Salicylic Acid
↑
M-Methyl Benzidine Y-31
↓
Salicylic Acid

Salicylic Acid
↑
O-Nitro Tolidine S-2
↓
1-Naphthol 4-Sulfonic Acid (NW Acid)

Salicylic Acid
↑
Thioaniline Y-32
↓
Salicylic Acid

Salicylic Acid
↑
Thioaniline M:M'-Disulfonic Acid Y-33
↓
Salicylic Acid

Salicylic Acid
↑
M:M'-Diamino Carbazole Y-36
↓
Salicylic Acid

←Dehydro Thio Para Toluidine Sulfonic Acid..... Y-24
←Primuline Y-25
←Di- and Tri-Sulfo Acid of Amino Pheno Triazine..... Y-28
(From Chrysoidine-Benzaldehyde, then sulfonated)

Salicylic Acid
↑
Magenta→Salicylic Acid Y-40
(Fuchsine)
↓
Salicylic Acid

←Tetra Methyl Diamino M'-Amino Triphenyl Methane.... G-8

Cleves' Acid
↓
Salicylic Acid Br.-24
↑
Para Nitro Aniline

Ortho Cresotinic Acid
←Meta Nitro Aniline..... Y-15
←2-Naphthylamine 4-Sulfonic Acid Y-16
←2-Naphthylamine 5-Sulfonic Acid Y-17
←2-Naphthylamine 6-Sulfonic Acid Y-18
Ortho Cresotinic Acid
↑
Benzidine O:O'-Disulfonic Acid Y-30
↓
Ortho Cresotinic Acid

Ortho Cresotinic Acid
↑
Thioaniline M:M'-Disulfonic Acid Y-33
↓
Ortho Cresotinic Acid

Meta Cresotinic Acid
←Para Nitro Aniline Ortho Sulfonic Acid..... O-2

Beta Resorcylic Acid
←Meta Nitro Aniline Y-19
←Para Nitro Aniline Y-20

Ortho Amino Salicylic Acid
(1) (2)
O.A.S.A.→1-Naphthylamine→1-Naphthol 4-Sulfo Acid. Bk. 30
(May use P.A.S.A. in place of O.A.S.A., and 1-Naphthol 5-Sulfo Acid in place of 1-Naphthol 4-Sulfo Acid)

Para Amino Salicylic Acid
(1) (2)
P.A.S.A.→1-Naphthylamine→1-Naphthol 4-Sulfo Acid. Bk.-32
(1) (2)
P.A.S.A.→1-Naphthylamine→1-Naphthol 5-Sulfo Acid. Bk.-33
(1) (2)
P.A.S.A.→1-Naphthylamine→1:8-Dihydroxynaphthylene 4-Sulfo Acid..... G-10
(1)
P.A.S.A.→1-Naphthylamine 6-or 7-Sulfo Acid
↓ (2)
2-Naphthol 3:6-Disulfo Acid Bk.-37
(1)
P.A.S.A.→1-Naphthylamine
↓ (3)
(1-Amino 8-Naphthol 4:6-Disulfo Acid
↑ (2)
Aniline) G-15
(1)
(P.A.S.A.→Cleves' Acid)
↓ (2)
Meta Toluylene Diamine* Br.-27
↑ (2')
(1')
(P.A.S.A.→Cleve's Acid)
(* May use Nitro Amino Salicylic Acid for P.A.S.A., 1-Naphthylamine for Cleves' Acid, Meta Phenylene Diamine or Meta Toluylene Diamine)

Para Amino Sulfo Salicylic Acid
(1) (2)
P.A.S.S.A.→1-Naphthylamine→1-Naphthol 4-Sulfo Acid Bk.-35
(1) (2)
P.A.S.S.A.→1-Naphthylamine→Beta Naphthol Bk.-34
→1-Naphthol 3:6-Disulfo Acid Bdx.-9

Nitro Amino Salicylic Acid
(1)
N.A.S.A.→Cleves' Acid
↓ (2)
Meta Phenylene Diamine* Br.-28
(1') ↑ (2')
N.A.S.A.→Cleves' Acid
(* May use 1-Naphthylamine in place of Cleves' Acid, Meta Toluylene Diamine for M.P.D.)

Meta Amino Benzoic Acid
→Salicylic Acid Y-9
→Diphenylamine Y-21

TABLE III (Cont.)

Ortho Chlor Meta Amino Benzoic Acid
→Salicylic Acid, plus NaOH fusion Y-10
(Hydrolysis of CL to OH)
Ortho Amino Para Sulfo Benzoic Acid
→1-Phenyl 3-Methyl 5-Pyrazolone Y-27

Amino Benzene and Derivatives

Aniline
→Salicylic Acid, plus subsequent nitration Y-2
→1:8-Dihydroxy Naphthalene 3:6-Disulfo Acid Bk.-1

Aniline
↓
Fustic Extract (Maclurin & Morin) Y-38
↑
Aniline

(1)
Para Amino Salicylic Acid→1-Naphthylamine G-15
↓ (3) (2)
(1-Amino 8-Naphthol 4:6-Disulfo Acid←Aniline)

Picramic Acid
↓ (1) Acid
1-Amino 8-Naphthol 4:6-Disulfo Acid G-13
↑ (2) Alk.
Aniline

Anthranilic Acid (*O-Amino Benzoic Acid*)
→Para Cresol Bdx.-1
→Salicylic Acid Y-8
→2-Naphthol 3:6-Disulfonic Acid Bdx.-2

Anthranilic Acid
↓ (1) Acid
2-Amino 5-Naphthol 7-Sulfo Acid Bk.-24
(Amino J-Acid)
↑ (2) Alk.
Nitro Amino Phenol

Sulfanilic Acid
→1:8 Dihydroxy Naphthalene 4-Sulfo Acid Bk.-5

Sulfanilic Acid*
↓
Salicylic Acid Br.-23
↑
Para Nitro Aniline
(* 1- or 2-Naphthylamine Mono Sulfo Acid or Amino Azo Benzene Mono Sulfo Acid may be used in place of Sulfanilic Acid)

Sulfanilic Acid
↓ (1)
Meta Amino Para Cresol G-9
↓ (2)
Beta Naphthol

(1)
Sulfanilic Acid→1-Naphthylamine
↓ (2)
2-Naphthol 6-Sulfo Acid V-10

(1)
Sulfanilic Acid→1-Naphthylamine
↓ (2)
1:8-Dihydroxy Naphthalene-4-Sulfonic Acid Bk.-29

Para Amino Benzaldehyde
→1:8-Dihydroxy Naphthalene 3:6-Disulfo Acid R-1
(Chromotropic Acid)
→Chromotropic Acid plus Phenyl Ethyl Hydrazine B-11
Ortho Nitro Aniline
→Pyrogallol Br.-1
Meta Nitro Aniline
→Salicylic Acid Y-1
→Ortho Cresotinic Acid Y-15
→Beta Resorcylic Acid Y-19
→Chromotropic Acid Bk.-2
Para Nitro Aniline
→Salicylic Acid Y-2
→Beta Resorcylic Acid Y-20
→Chromotropic Acid Bk.-3

Sulfanilic Acid
↓ (1)
Salicylic Acid Br.-23
↑ (2)
Para Nitro Aniline

Cleves' Acid
↓ (1)
Salicylic Acid Br.-24
↑ (2)
Para Nitro Aniline

Para Nitro Aniline Ortho Sulfonic Acid
→Salicylic Acid O-1
→Meta Cresotinic Acid O-2
Para Chlor Aniline Meta Sulfonic Acid
(1)
P.Cl.A.M.S.A.→Meta Amino Para Cresol
↓ (2)
Beta Naphthol G-12
Para Amino Acetanilide
(Acetyl Para Phenylene Diamine)
→Salicylic Acid Y-3
→Chromotropic Acid Bk.-4
→Acetyl 1-Amino 8-Naphthol 3:6-Disulfonic Acid R-2

Salicylic Acid
↑ (1)
P.A.A.A.; plus hydrolysis (2) R-12
↓ (3)
Bronner's Acid

Salicylic Acid
↑ (1)
P.A.A.A.; plus hydrolysis (2) Bdx.-12
↓ (3)
NW Acid

Salicylic Acid
↑ (1)
P.A.A.A.; plus hydrolysis (2) Bk.-27
↓ (3)
Chromotropic Acid*
(* May use 1:8-Dihydroxy-Naphthalene 4-Sulfonic Acid)

Para Amino Dimethyl Aniline
(Dimethyl Para Phenylene Diamine)
→Pyrogallol V-1
Ortho Toluidine
→1-Phenyl 3-Methyl 5-Pyrazolone Y-26
→1:8-Dihydroxy Naphthalene 4-Sulfonic Acid Bk.-6
Ortho Anisidine
→Salicylic Acid Y-6
Para Toluidine
→Salicylic Acid; then mononitrated Y-5
→Salicylic Acid Y-4
Meta Nitro Para Toluidine
→Salicylic Acid Y-5
1-*Methyl* 2-*Nitro* 4-*Sulfonamino Toluene*
(Ortho Nitro Para Toluidine plus Para Toluene Sulfonyl Chloride)
←Picramic Acid Bdx.-10
Para Phenetidine
→Salicylic Acid Y-7
Para Toluidine Ortho Sulfonic Acid
(1) (2)
P.T.O.S.A.*→1-Naphthylamine→Schaeffer's Acid V-11
(* May use Para Toluidine Meta Sulfo Acid)

Phenol Derivatives (Except Carboxylic Acid Derivatives)

Phenol
←Picramic Acid Br.-11
Meta Amino Phenol
←Picramic Acid Br.-13
1-Amino 2-Naphthol 4-Sulfonic Acid
↓ (1) (2)
Meta Amino Phenol→Resorcinol Gr.-11

TABLE III (Cont.)

Para Amino Phenol
→Pyrogallol Br.-2
Ortho Cresol
←Picramic Acid Br.-14
Para Cresol
←Picramic Acid Br.-15
←Ortho Amino Benzoic Acid (Anthranilic Acid) Bdx.-1
←Naphthionic Acid (1-Naphthylamine 4-Sulfo Acid) V-7
Meta Amino Para Cresol
Sulfanilic Acid
↓ (1)
Meta Amino Para Cresol G-9
↓ (2)
Beta Naphthol

Para Chlor Aniline Sulfo Acid
↓ (1)
Meta Amino Para Cresol G-12
↓ (2)
Beta Naphthol
Para Nitro Ortho Amino Phenol
→Meta Phenylene Diamine Sulfonic Acid Br.-7
→H Acid (1-Amino 8-Naphthol 3:6-Disulfo Acid) G-4
→Chromotropic Acid B-6
→Resorcinol; plus sulfonation Bdx.-4
Anthranilic Acid
↓ (1) Acid
2-Amino 5-Naphthol 7-Sulfo Acid Bk.-24
↑ (2) Alk.
Nitro Amino Phenol
Acetyl Diamino Phenol
→1-Amino 8-Naphthol 4-Sulfonic Acid B-2
Acetyl Diamino Phenol Sulfonic Acid
→Beta Naphthol B-3; Bk.-19
Ortho Amino Phenol Para Sulfonic Acid
→Meta Phenylene Diamine Br.-6
→Resorcinol Bdx.-3
→Beta Naphthol V-2
→1:5-Dihydroxy Naphthalene Bk.-7
→Chromotropic Acid B-4
Ortho Nitro Ortho Amino Phenol Para Sulfonic Acid
→Beta Naphthol Bk.-8
Para Amino Phenol 2:6-Disulfonic Acid
→Pyrogallol Br.-18
2:6-Diamino Phenol 4-Sulfonic Acid
Beta Naphthol
↑
2:6-D.A.P. 4-Sulfo Acid Bk.-25
↓
Beta Naphthol

Beta Naphthol
↑
2:6-D.A.P. 4-Sulfo Acid Bk.-28
↓
2-Naphthol 6-Sulfo Acid

Ortho Amino Ortho Cresol Para Sulfonic Acid
→Beta Naphthol V-4
→Resorcinol Bdx.-5
Ortho Amino Para Cresol Sulfonic Acid
→Beta Naphthol V-3
→Resorcinol Bdx.-6
→1-Phenyl 3-Methyl 5-Pyrazolone R-3
Nitro Amino Cresol
→Sulfophenyl Methyl Pyrazolone R-4
→1:5-Naphthol Sulfo Acid V-6
→NW Acid V-5
→H Acid G-6
→1-Amino 8-Naphthol 4-Sulfo Acid G-5
→1-Amino 8-Naphthol 4:6-Disulfo Acid G-7
→Chromotropic Acid B-5
Ortho Nitro Ortho Amino Para Cresol
→Phenyl 1-Naphthylamine 8-Sulfo Acid Bk.-9
→Resorcinol; plus sulfonation Bdx.-8
Picramic Acid
→Meta Phenylene Diamine Br.-8
→Meta Toluylene Diamine Br.-9
→Meta Phenylene Diamine Sulfo Acid Br.-10
→Phenol Br.-11
→Resorcinol Br.-12
→Meta Amino Phenol Br.-13
→Ortho Cresol Br.-14
→Para Cresol Br.-15
→Chlor Meta Toluylene Diamine Br.-16
→1-Methyl 2-Amino 4-Sulfonamino Toluene Bdx.-10
→Para Toluol Sulfo Meta Toluylene Diamine Bdx.-11
→Beta Naphthylamine G-1
→Naphthionic Acid G-2
Picramic Acid
↓ (1) Acid
1-Amino 8-Naphthol 4:6-Disulfo Acid G-13
↑ (2) Alk.
Aniline
Picramic Acid→Cleves' Acid→Beta Naphthol Bk.-36
→1:5-Naphthylamine Sulfonic Acid G-3

Di and Tri Hydroxy Benzenes and Naphthalenes and Sulfonic Acids

Resorcinol
←Picramic Acid Br.-12
←Ortho Amino Phenol Para Sulfonic Acid Bdx.-3
←Ortho Amino Cresol Para Sulfonic Acid Bdx.-5
←Ortho Amino Para Cresol Sulfonic Acid Bdx.-6
←Nitro Amino Phenol; plus sulfonation Bdx.-4
←Nitro Amino Ortho Cresol; plus sulfonation Bdx.-7
←Ortho Amino Nitro Para Cresol; plus sulfonation Bdx.-8
Naphthionic Acid
↓
Resorcinol Br.-22
↑
Naphthionic Acid

1-Amino 2-Naphthol 4-Sulfo Acid
↓
Meta Amino Phenol→Resorcinol G-11

Salicylic Acid
↑
Benzidine O-4
↓
Resorcinol

Pyrogallol
←Ortho Nitro Aniline Br.-1
←Dimethyl Para Phenylene Diamine V-1
←Para Amino Phenol Br.-2
←4-Amino Phenol 2:6-Disulfonic Acid Br.-18
1:5-Dihydroxy Naphthalene
←Ortho Amino Phenol Para Sulfonic Acid Bk.-7
2:7-Dihydroxy Naphthalene
Salicylic Acid
↑
Benzidine Y-37
↓
2:7-Dihydroxy Naphthalene
1:8-Dihydroxy Naphthalene
←2-Amino 3-Naphthol 6-Sulfonic Acid Bk.-17
1:8-Dihydroxy Naphthalene 4-Sulfonic Acid
←Toluidine Bk.-6
←Sulfanilic Acid Bk.-5

Para Amino Salicylic Acid
↓
1-Naphthylamine
↓
1:8-Dihydroxy Nap. 4-Sulfo G-10

Sulfanilic Acid→1-Naphthylamine
↓
1:8-Dihydroxy Nap. 4-Sulfo Bk.-29
Chromotropic Acid
(1:8-Dihydroxy Naphthalene 3:6-Disulfonic Acid)
←Aniline Bk.-1; B-1
←Meta Nitro Aniline Bk.-2
←Para Nitro Aniline Bk.-3
←Para Amino Acetanilide Bk.-4
←Para Amino Benzaldehyde R-1
←Para Amino Benzylidine Ethyl Phenyl Hydrazone B-11
←1-Naphthylamine Bk.-10
←5-Nitro 2-Amino Phenol B-6
←Naphthionic Acid Bk.-11

TABLE III (Cont.)

Salicylic Acid
↑ (1)
Para Amino Acetanilide; plus hydrolysis (2) Bk.-27
↓ (3)
Chromotropic Acid

←Ortho Amino Phenol Para Sulfonic Acid B-4
←Nitro Amino Para Cresol B-5

Alpha and Beta Naphthols and Their Sulfonic Acids

Alpha Naphthol

←5-Nitro 1-Amino 2-Naphthol 4-Sulfonic Acid Bk.-14
←1-Amino 2-Naphthol 4-Sulfonic Acid Bk.-12
←Naphthionic Acid Br.-19

Alpha Naphthol 4-Sulfonic Acid (NW Acid)

←Nitro Amino Cresol V-5
←Naphthionic Acid B-8
←Ortho Amino Azo Toluene R-22

Salicylic Acid
↑ (1)
Para Amino Acetanilide; plus hydrolysis (2) Bdx.-12
↓ (3)
NW Acid

Salicylic Acid
↑ (1)
Benzidine R-13
↓ (2)
NW Acid

Salicylic Acid
↑ (1)
2-Nitro Benzidine R-15
↓ (2)
NW Acid

Salicylic Acid
↑ (1)
2-Nitro Tolidine S-2
↓ (2)
NW Acid

Para Amino Salicylic Acid
↓ (1) (2)
1-Naphthylamine→NW Acid Bk.-32
Ortho Amino Salicylic Acid
↓ (1) (2)
1-Naphthylamine→NW Acid Bk.-31
Para Amino Sulfo Salicylic Acid
↓ (1) (2)
1-Naphthylamine→NW Acid Bk.-35

Alpha Naphthol 5-Sulfonic Acid

←Naphthionic Acid B-9
←Nitro Amino Cresol V-6
Para Amino Salicylic Acid
↓ (1) (2)
1-Naphthylamine→1-Naphthol 5-S.A. Bk.-33
Ortho Amino Salicylic Acid
↓ (1) (2)
1-Naphthylamine→1-Naphthol 5-S.A. Bk.-30

Beta Naphthol

←Anthranilic Acid Br.-3
←Ortho Amino Phenol Para Sulfo Acid V-2
←6-Nitro 2-Amino Phenol 4-Sulfonic Acid Bk.-8
←Ortho Amino Para Cresol Sulfonic Acid V-3
←Amino Azo Benzene Para Sulfonic Acid R-18
←Ortho Amino Azo Toluene Para Sulfonic Acid R-19
←Acetyl Diamino Phenol Sulfonic Acid B-3
←Dehydro Thio Para Toluidine Sulfonic Acid R-6
←Primuline R-7
←Ortho Amino Ortho Cresol Para Sulfonic Acid V-4
←2-Amino 4-Sulfo Acid 6-Acetylamino Phenol Bk.-19
←1-Amino 2-Naphthol 4-Sulfonic Acid Bk.-13
←2-Amino 3-Naphthol 6-Sulfonic Acid Bk.-16
←5-Nitro 1-Amino 2-Naphthol 4-Sulfonic Acid Bk.-15

Beta Naphthol
↑
2:6-Diamino Phenol 4-Sulfonic Acid Bk.-25
↓
Beta Naphthol

Beta Naphthol
↑
2:6-Diamino Phenol 4-Sulfonic Acid Bk.-28
↓
Schaeffer's Acid

Salicylic Acid
↑
Nitro Benzidine; plus sulfonation R-16
↓
Beta Naphthol

Beta Naphthol
↑
Benzidine O:O'-Disulfonic Acid R-9
↓
Beta Naphthol

Beta Naphthol
↑
O-Tolidine M:M'-Disulfonic Acid R-10
↓
Beta Naphthol

(1)
Sulfanilic Acid→Meta Amino Para Cresol
↓ (2)
Beta Naphthol G-9

(1) (2)
Picramic Acid→Cleves' Acid→Beta Naphthol Bk.-36

Para Amino Sulfo Salicylic Acid
↓ (1) (2)
1-Naphthylamine→Beta Naphthol Bk.-34

Para Chlor Meta Aniline Sulfo Acid
↓ (1) (2)
Meta Amino Para Cresol→Beta Napthol G-12

Beta Naphthol 6-Sulfonic Acid (Schaeffer's Acid)

←Isodehydro Thio Meta Xylidine R-8
←Ortho Amino Azo Toluol R-20

Schaeffer's Acid
↑
2:6-Diamino Phenol 4-Sulfonic Acid Bk.-28
↓
Beta Naphthol

Schaeffer's Acid
↑
Thioaniline R-11
↓
Schaeffer's Acid

(1)
Sulfanilic Acid→1-Naphthylamine
↓ (2)
Schaeffer's Acid V-10

Para Toluidine O-(or M-) Sulfonic Acid
↓ (1) (2)
1-Naphthylamine→Schaeffer's Acid V-11

Beta Naphthol 3:6-Disulfonic Acid

←Anthranilic Acid Bdx.-2
←Ortho Amino Azo Toluol R-23
←Amino Azo Xylene R-25
Para Amino Salicylic Acid
↓ (1)
(2)
Cleves' Acid→2-Naphthol 3:6-Disulfo Acid Bk.-37

Bisulfite Compound of 1-Nitroso 2-Naphthol

←1-Naphthylamine Br.-20
←2-Naphthylamine Br.-21

Alpha and Beta Naphthylamines and Their Sulfonic Acids

Alpha Naphthylamine

→1:8-Dihydroxy Naphthalene 3:6-Disulfo Acid Bk.-10
(Chromotropic Acid)
→Bisulfite Compound of 1-Nitroso 2-Naphthol Br.-20

TABLE III (Cont.)

Sulfanilic Acid→1-Naphthylamine
(1) ↓(2)
Schaeffer's Acid V-10

(1)
Sulfanilic Acid→1-Naphthylamine
↓2
1:8-Dihydroxy Naphthalene 4-Sulfo Acid..... Bk.-29

Para Amino Salicylic Acid
↓(1) (2)
1-Naphthylamine→NW Acid Bk.-32

Para Amino Salicylic Acid
↓(1) (2)
1-Naphthylamine→1-Naphthol 5-Sulfo Acid Bk.-33

Para Amino Salicylic Acid→1-Naphthylamine
(1) ↓(2)
1:8-Dihydroxy Naphthalene 4-Sulfo Acid G-10

Para Amino Salicylic Acid Sulfonic Acid
↓(1) (2)
1-Naphthylamine→NW Acid Bk.-35

Para Amino Sulfo Salicylic Acid
↓(1) (2)
1-Naphthylamine→Beta Naphthol Bk.-36

Ortho Amino Salicylic Acid
↓(1) (2)
1-Naphthylamine→NW Acid Bk.-31

Ortho Amino Salicylic Acid
↓(1) (2)
1-Naphthylamine→1-Naphthol 5-S.A. Bk.-30

Para Toluidine Sulfo Acid
↓(1) (2)
1-Naphthylamine→Schaeffer's Acid V-11

Para Amino Salicylic Acid→1-Naphthylamine
(1) ↓(2)
(1-Amino 8-Hydroxy Naphthalene 4-Sulfo Acid
↑(1')
Aniline) G-15

Para Amino Salicylic Acid→Cleves' Acid
(1) ↓(2)
Meta Phenylene Diamine Br.-27
(1') ↑(2')
Para Amino Salicylic Acid→Cleves' Acid

Alpha Naphthylamine 4-Sulfonic Acid
(Naphthionic Acid)
←Picramic Acid Br.-17
→Para Cresol V-7
→Alpha Naphthol Br.-19
→NW Acid B-8
→1-Naphthol 5-Sulfonic Acid B-9
→Chromotropic Acid Bk.-11

Resorcinol
↑
Naphthionic Acid Br.-22
↓
Resorcinol

Salicylic Acid
↑
Benzidine O-5
↓
Naphthionic Acid

Alpha Naphthylamine 5-Sulfonic Acid
←Picramic Acid G-3
←1-Naphthylamine 4-Sulfo Acid B-9

Alpha Naphthylamine 6-7 Sulfonic Acid (Cleves' Acid)
(1) (2)
Picramic Acid→Cleves' Acid→Beta Naphthol Bk.-36

Para Amino Salicylic Acid
↓(1) (2)
Cleves' Acid→2-Naphthol 3:6-Disulfo Acid..... Bk.-37

Para Amino Salicylic Acid→Cleves' Acid
(1) ↓(2)
Meta Phenylene Diamine Br.-27
(1') ↑(2')
Para Amino Salicylic Acid→Cleves' Acid

Cleves' Acid
↓
Salicylic Acid Br.-24
↑
Para Nitro Aniline

Phenyl 1-Naphthylamine 8-Sulfonic Acid
←Ortho Nitro Ortho Amino Para Cresol..... Bk.-9

Beta Naphthylamine
←Picramic Acid G-1
→Bisulfite Compound of 1-Nitroso 2-Naphthol..... Br.-21

Beta Naphthylamine 4-Sulfonic Acid
→Salicylic Acid Y-12
→Ortho Cresotinic Acid Y-16

Beta Naphthylamine 5-Sulfonic Acid
→Salicylic Acid Y-13
→Ortho Cresotinic Acid Y-17

Beta Naphthylamine 6-Sulfonic Acid
(Bronner's Acid)
→Salicylic Acid Y-13
→Ortho Cresotinic Acid Y-18
←Ortho Amino Azo Toluol..... R-21

Salicylic Acid
↑(1)
Para Amino Acetanilide; plus hydrolysis (2)..... R-12
↓(3)
Bronner's Acid

Beta Naphthylamine 7-Sulfonic Acid
Salicylic Acid
↑
Benzidine O-6
↓
2-Naphthylamine 7-Sulfo Acid

Ethyl Beta Naphthylamine 7-Sulfonic Acid
←Ortho Amino Azo Toluol..... R-24

Beta Naphthylamine 6:8-Disulfonic Acid
→Salicylic Acid Y-14

Amino Naphthols and Their Derivatives

1:5-*Amino Naphthol*
← 2-Amino 7-Sulfo 1-Naphthol..... B-10

1-*Amino 2-Naphthol 4-Sulfonic Acid*
→Alpha Naphthol Bk.-12
→Beta Naphthol Bk.-13
→1-Phenyl 3-Methyl 5-Pyrazolone R-5

1-Amino 2-Naphthol 4-Sulfo Acid
↓(1) (2)
Meta Amino Phenol→Resorcinol G-11

5-*Nitro* 1-*Amino 2-Naphthol 4-Sulfonic Acid*
→Alpha Naphthol Bk.-14
→Beta Naphthol Bk.-15

1-*Amino 8-Naphthol 3:6-Disulfonic Acid (H Acid)*
←5-Nitro 2-Amino Phenol G-4
←Nitro Amino Ortho Cresol..... G-6

Acetyl 1-*Amino 8-Naphthol 3:6-Disulfonic Acid*
(Acetyl H-Acid)
←Acetyl Para Phenylene Diamine..... R-2

Alkylated 1-*Amino 8-Naphthol 3:6-Disulfonic Acid*
←2-Amino 3-Naphthol 6-Sulfonic Acid..... Bk.-18

1-*Amino 8-Naphthol 4-Sulfonic Acid*
←Nitro Amino Ortho Cresol..... G-5
←Acetyl Diamino Phenol B-2

1-*Amino 8-Naphthol 4:6-Disulfonic Acid*
←Nitro Amino Ortho Cresol..... G-7

Picramic Acid
↓(1) Acid
1-Amino 8-Naphthol 4:6-Disulfo Acid G-13
↑(2) Alk.
Aniline

TABLE III (Cont.)

(1)
Para Amino Salicylic Acid→1-Naphthylamine
↓ (2) (1')
(1-Amino 8-Nap. 4:6-D.S.A.←Aniline) G-15

Amino 7-Sulfo 1-Naphthol
→1:5-Amino Naphthol B-10

Amino 3-Naphthol 6-Sulfonic Acid
→Beta Naphthol Bk.-16
→1:8-Dihydroxy Naphthalene Bk.-17
→Alkylated 1-Amino 8-Naphthol 3:6-Disulfo Acid Bk.-18

2-Amino 5-Naphthol 7-Sulfonic Acid
Anthranilic Acid
↓ (1) Acid
2-Amino 5-Naphthol 7-Sulfonic Acid.....Bk.-24
↑ (2) Alk.
Nitro Amino Phenol

2-Amino 8-Naphthol 6-Sulfonic Acid
Salicylic Acid
↑ (1) Alk.
Benzidine R-14
↓ (2) Acid
2-Amino 8-Naphthol 6-Sulfo Acid

Salicylic Acid
↑ (1) Alk.
Benzidine Br.-25
↓ (2) Alk.
2-Amino 8-Naphthol 6-Sulfo Acid

Diamino Benzenes and Derivatives

Meta Phenylene Diamine
←Picramic Acid .....Br. 8
←Ortho Amino Phenol Para Sulfo Acid.....Br.-6
←Meta Amino Phenyl Glycine.....Br.-4
←Amino Azo Benzene Para Sulfonic Acid.....Br.-26

(Para Amino Salicylic Acid→Cleves' Acid)
(1) ↓ (2)
Meta Phenylene Diamine.....Br.-27
(1') ↑ (2')
(Para Amino Salicylic Acid→Cleves' Acid)

Meta Phenylene Diamine Sulfonic Acid
←Para Nitro Amino Phenol.....Br.-7
←Picramic Acid Br.-10

Meta Phenylene Diamine Meta Sulfonic Acid (Di)
←Primuline O-3

Chlor Meta Phenylene Diamine
←Meta Amino Phenylene Diamine.....Br.-5

Para Phenylene Diamine
Salicylic Acid
↑ (1)
Para Amino Acetanilide; plus hydrolysis (2).....Bdx.-12
↓ (3)
NW Acid

Salicylic Acid
↑ (1)
Para Amino Acetanilide; plus hydrolysis (2).....R-12
↓ (3)
Bronner's Acid

Salicylic Acid
↑ (1)
Para Amino Acetanilide; plus hydrolysis (2).....Bk.-27
↓ (3)
Chromotropic Acid

Meta Toluylene Diamine
←Picramic Acid Br.-9
(1)
(Para Amino Salicylic Acid→Cleves' Acid)
↓ (2)
Meta Toluylene Diamine Br.-27
(1') ↑ (2')
(Para Amino Salicylic Acid→Cleves' Acid)

Para Toluol Sulfo Meta Toluylene Diamine
←Picramic Acid Bdx.-11

Amino Azo Benzene Derivatives

Amino Azo Benzene Para Sulfonic Acid
→Salicylic Acid R-17
→Meta Phenylene Diamine Br.-26
→Beta Naphthol R-18

Ortho Amino Azo Toluene
→NW Acid R-22
→Schaeffer's Acid R-20
→2-Naphthol 3:6-Disulfonic Acid R-23
→Bronner's Acid R-21
→2-Ethyl Naphthylamine 7-Sulfonic Acid.....R-24

Ortho Amino Azo Toluene Para Sulfonic Acid
→Beta Naphthol R-19

Amino Azo Xylene
→2-Naphthol 3:6-Disulfonic Acid R-25

Dinuclear Diamines and Derivatives

Benzidine
→Salicylic Acid (1 Mol); plus Na_2SO_3.....Y-22
→Salicylic Acid (1 Mol); plus hydrolysis.....Y-23

Salicylic Acid
↑ (1)
Benzidine O-4
↓ (2)
Resorcinol

Salicylic Acid
↑ (1)
Benzidine R-13
↓ (2)
NW Acid

Salicylic Acid
↑ (1)
Benzidine O-5
↓ (2)
Naphthionic Acid

Salicylic Acid
↑ (1)
Benzidine O-6
↓ (2)
2-Naphthylamine 7-Sulfo Acid

Salicylic Acid
↑ (1)
Benzidine Y-37
↓ (2)
2:7-Dihydroxy Naphthalene

Salicylic Acid
↑ (1)
Benzidine R-14
↓ (2)
2-Amino 8-Naphthol 6-Sulfo Acid

Salicylic Acid
↑ (1)
Benzidine Br.-25
↓ (2)
2-Amino 8-Naphthol 6-Sulfo Acid

Nitro Benzidine
Salicylic Acid
↑ (1)
Nitro Benzidine; plus sulfonation.....R-16
↓ (2)
Beta Naphthol

Salicylic Acid
↑ (1)
Nitro Benzidine; plus sulfonation.....Y-35
↓ (2)
Salicylic Acid

Salicylic Acid
↑ (1)
Nitro Benzidine R-15
↓ (2)
NW Acid

TABLE III (Cont.)

Benzidine Disulfonic Acid
Salicylic Acid
↑
Benzidine Disulfonic Acid Y-29
↓
Salicylic Acid

Ortho Cresotinic Acid
↑
Benzidine Disulfonic Acid Y-30
↓
Ortho Cresotinic Acid

Beta Naphthol
↑
Benzidine Disulfonic Acid R-9
↓
Beta Naphthol

Methyl Benzidine
Salicylic Acid
↑
Methyl Benzidine Y-31
↓
Salicylic Acid

Ortho Tolidine Disulfonic Acid
Beta Naphthol
↑
Ortho Tolidine Disulfo Acid..... R-10
↓
Beta Naphthol

Nitro Tolidine
Salicylic Acid
↑ (1)
Nitro Tolidine S-2
↓ (2)
NW Acid

Thioaniline
Salicylic Acid
↑
Thioaniline Y-32
↓
Salicylic Acid

Schaeffer's Acid
↑
Thioaniline R-11
↓
Schaeffer's Acid

Thioaniline Disulfonic Acid
Salicylic Acid
↑
Thioaniline Disulfonic Acid Y-33
↓
Salicylic Acid

Ortho Cresotinic Acid
↑
Thioaniline Disulfonic Acid Y-34
↓
Ortho Cresotinic Acid

Diamino Carbazole
Salicylic Acid
↑
Diamino Carbazole Y-36
↓
Salicylic Acid

Triamino Diphenyl Tolyl Carbinol
(Magenta, Fuchsine)
Salicylic Acid
↑
Magenta→Salicylic Acid Y-40
(C.I.677)
↓
Salicylic Acid

Miscellaneous

Meta Amino Phenyl Glycine
→Meta Phenylene Diamine..... Br.-4
→Chlor Meta Phenylene Diamine..... Br.-5
Tetra Methyl Diamino M'-Amino Triphenyl Methane
→Salicylic Acid; plus oxidation..... G-8
Primuline
→Meta Phenylene Diamine Meta Disulfonic Acid..... O-3
→Salicylic Acid Y-25
→Beta Naphthol R-7
Dehydro Thio Para Toluidine Sulfo Acid
→Salicylic Acid Y-24
→Beta Naphthol R-6
Isodehydro Thio Meta Xylidine
→Schaeffer's Acid R-8
Di & Tri Sulfo Acids of Di Pheno Triazine
(Sulfonation of Chrysoidine-Benzaldehyde Condensation)
→Salicylic Acid Y-28
Fustic Extract-Maclurin-Morin
Aniline
↓
Fustic Extract Y-38
↑
Aniline
1-*Phenyl 3-Methyl 5-Pyrazolone*
←Ortho Toluidine Y-26
←Ortho Amino Para Sulfo Benzoic Acid..... Y-27
←Ortho Amino Para Cresol Sulfo Acid..... R-3
←1-Amino 2-Naphthol 4-Sulfonic Acid..... R-5
Sulfo Phenyl Methyl Pyrazolone
←Nitro Amino Cresol R-4
Diphenylamine
←Meta Amino Benzoic Acid..... Y-21
Para Amino Benzylidine Ethyl Phenyl Hydrazone
→Chromotropic Acid B-11

IV. CHEMICAL CONSTITUTION OF CHROME AZO DYES CLASSIFIED ACCORDING TO COLOR

Yellow: In Table IV, the forty yellow chrome azo dyes are listed. Of these 70 per cent are monazo colors. Included are the famed alizarine and diamond yellows. The molecular weight range is from 272 to 766, with 80 per cent of all yellow combinations lying between 272 and 550 molecular weight. A majority have carboxylic groups and fall into the salicylic acid colors. The chrome azo colors are not pure yellows but rather more of the mustard shade. In general the yellows are of relatively low molecular weight and simple chemical constitution. Certain acetoacetarylides may be used for chrome yellows but these have not been too successful as second components excepting in certain abnormal chrome colors. In this and the following nine tables the empirical formula, molecular weight, Colour Index, and Schultz numbers are given.

Orange: In Table V, the chemical constitutions of seven orange chrome azo colors are given. Their molecular weight range is 389 to 798. The two molecular weight range peaks are 400-500 and 600-700. All contain sulfonic groups, and most carboxylic groups as well. Most are in part salicylic acid dyes. Honors are divided between monazo and primary disazo dyes.

Scarlet: In Table VI, two scarlet chrome azo dyes are listed. Both are primary disazo dyes. Their molecular weight averages 671.

TABLE IV
Yellow Chrome Azo Dyes

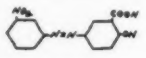
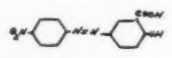
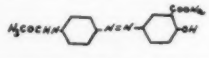
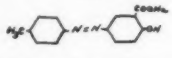
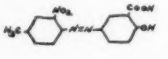
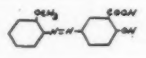
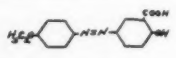
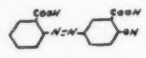
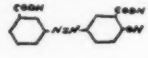
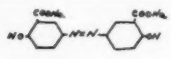
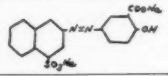
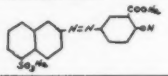
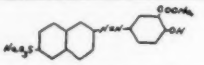
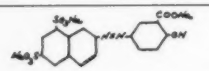
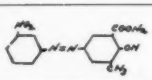
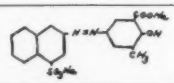
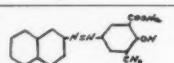
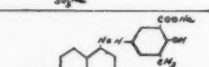
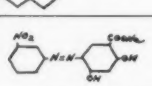
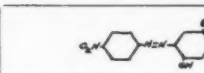
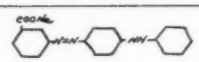
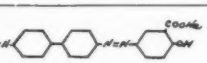
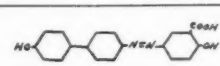
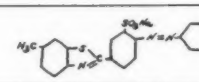
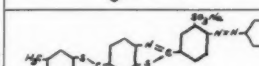
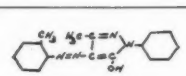
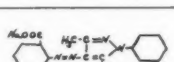
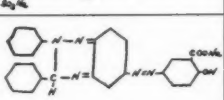
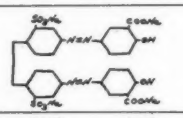
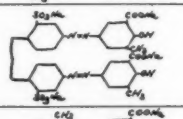
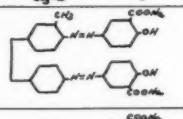
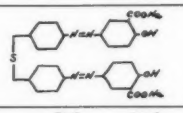
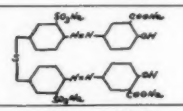
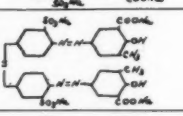
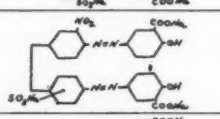
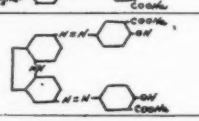
	Monazo Dyes (P→C)		Emperical Formula Molecular weight
1.		C.I.36 Sch.55	$C_{12}H_9N_3O_5$ 287
2.		C.I.40 Sch.66	$C_{12}H_9N_3O_5$ 287
3.		C.I.52 Sch.109	$C_{15}H_{12}N_3O_4Na$ 321
4.		Sch.81	$C_{14}H_{11}N_2O_3Na$ 278
5.		C.I.67 Sch.83	$C_{14}H_{11}N_3O_5$ 301
6.		C.I.112 Sch.152	$C_{14}H_{12}N_2O_4$ 272
7.		C.I.122 Sch.157	$C_{15}H_{14}N_2O_4$ 286
8.		C.I.213 Sch.255	$C_{14}H_{10}N_2O_5$ 286
9.		C.I.218 Sch.257	$C_{14}H_{10}N_2O_5$ 286
10.		C.I.219 Sch.258	$C_{14}H_8N_2O_6Na_2$ 346
11.		C.I.195 Sch.230	$C_{17}H_{10}N_2O_6SNa_2$ 416
12.		C.I.195 Sch.230	$C_{17}H_{10}N_2O_6SNa_2$ 416
13.		C.I.195 Sch.230	$C_{17}H_{10}N_2O_6SNa_2$ 416
14.		C.I.197 Sch.226	$C_{17}H_9N_2O_9S_2Na_3$ 518
15.		C.I.36 Sch.56	$C_{14}H_{11}N_3O_5$ 301
16.		C.I.195 Sch.230	$C_{18}H_{12}N_2O_6SNa_2$ 430
17.		C.I.195 Sch.230	$C_{18}H_{12}N_2O_6SNa_2$ 430
18.		C.I.195	$C_{18}H_{12}N_2O_6SNa_2$ 430
19.		C.I.37 Sch.57	$C_{12}H_7N_3O_6Na$ 325
20.		C.I.41 Sch.68	$C_{12}H_8N_3O_6Na$ 325
21.		Sch.256	$C_{17}H_{14}N_3O_2Na$ 329
22.		C.I.109 Sch.112	$C_{17}H_{12}N_4O_6SNa_2$ 470
23.		C.I.110 Sch.113	$C_{17}H_{14}N_2O_4$ 334
24.		C.I.223	$C_{21}H_{13}N_3O_6S_2Na_2$ 513
25.		C.I.223	$C_{28}H_{16}N_4O_6S_3Na_2$ 646
26.		C.I.638	$C_{17}H_{16}N_4O$ 292
27.		C.I.651	$C_{17}H_{12}N_4O_6SNa_2$ 446
28.		C.I.229 Sch.260	$C_{26}H_{18}N_6O_3Na$ 471
	Primary Disazo Dyes (R , where C=C')		
29.		C.I.442 Sch.432	$C_{26}H_{14}N_4O_{12}S_4Na_4$ 730
30.		C.I.442 Sch.433	$C_{28}H_{18}N_4O_{12}S_4Na_4$ 758
31.		Sch.442	$C_{27}H_{18}N_4O_6Na_2$ 540
32.		C.I.343 Sch.330	$C_{26}H_{16}N_4O_6SNa_2$ 558
33.		Sch.331	$C_{26}H_{14}N_4O_{12}S_3Na_4$ 762
34.		Sch.331	$C_{26}H_{18}N_4O_{12}S_4Na_4$ 734
35.		C.I.433 Sch.428	$C_{26}H_{14}N_5O_{10}SNa_3$ 673
36.		C.I.445 Sch.531	$C_{26}H_{16}N_6O_6Na_2$ 539

TABLE IV (Cont.)

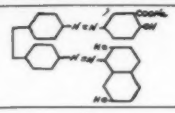
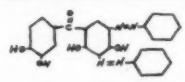
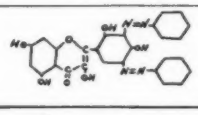
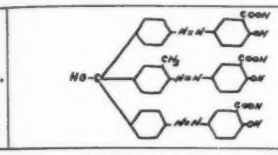
Primary Disazo Dyes (R⟨C⟩C', where C≠C')			
37.		C.I.414 Sch.402	$C_{29}H_{19}N_4O_5Na$ 526
Primary Disazo Dyes (R⟨R⟩C, where R=R')			
38.		C.I.237 Sch.310	$C_{26}H_{18}N_4O_6$ 470
39.		C.I.237 Sch.310	$C_{27}H_{18}N_4O_7$ 510
Trisazo Dyes (R⟨C⟩C', where C=C'=C'')			
40.		C.I.603 Sch.686	$C_{41}H_{30}N_6O_{10}$ 766

TABLE V Orange Chrome Azo Dyes

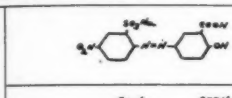
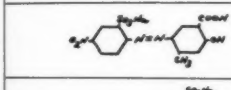
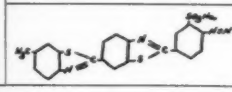
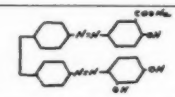
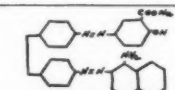
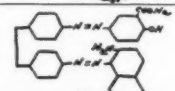
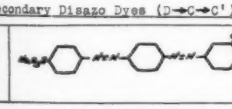
Monazo Dyes (D→C)			Emperical Formula Molecular Weight
1.		C.I.157 Sch.167	$C_{18}H_{12}N_2O_8S_2Na_2$ 494
2.		Sch.167	$C_{19}H_{14}N_2O_8S_2Na_2$ 508
3.		C.I.222	$C_{27}H_{17}N_4O_9S_2Na_3$ 798
Primary Disazo Dyes (D⟨C⟩C', where C≠C')			
4.		C.I.412 Sch.401	$C_{25}H_{17}N_4O_5Na$ 476
5.		C.I.415 Sch.404	$C_{29}H_{19}N_5O_6SNa_2$ 611
6.		C.I.416 Sch.406	$C_{29}H_{19}N_5O_6SNa_2$ 611
Secondary Disazo Dyes (D→C→C')			
7.		C.I.274 Sch.567	$C_{19}H_{12}N_4O_6SNa_2$ 470

TABLE VI Scarlet Chrome Azo Dyes

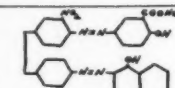
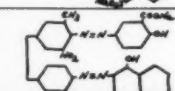
Primary Disazo Dyes (D⟨C⟩C', where C≠C')			Emperical Formula Molecular Weight
1.		C.I.431 Sch.429	$C_{29}H_{17}N_5O_9SNa_2$ 657
2.		C.I.431	$C_{31}H_{21}N_5O_9SNa_2$ 685

TABLE VII
Red Chrome Azo Dyes

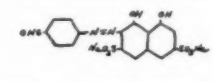
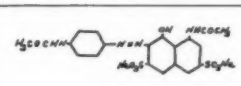
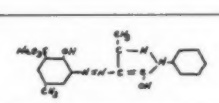
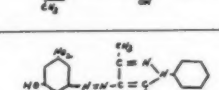
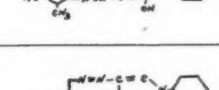
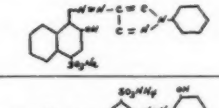
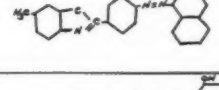
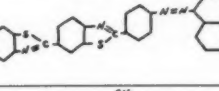
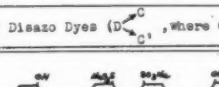
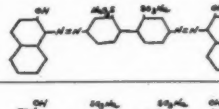
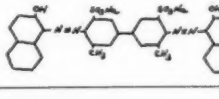
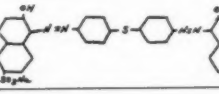
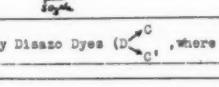
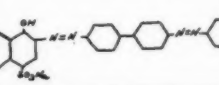
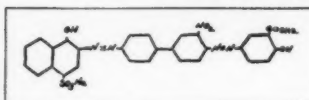
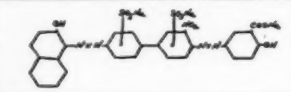
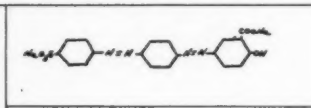
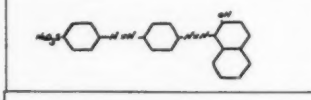
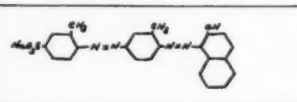
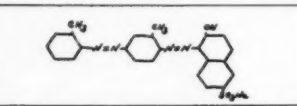
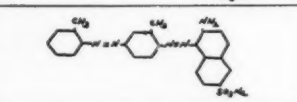
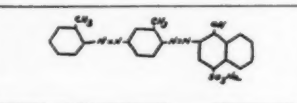
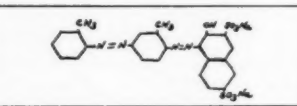
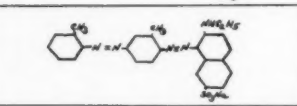
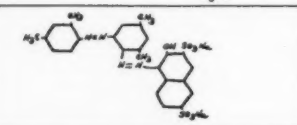
Monazo Dyes (D→C)			Emperical Formula Molecular Weight
1.		C.I.124 Sch.163	$C_{17}H_{10}N_2O_9S_2Na_2$ 496
2.		Sch.110	$C_{20}H_{16}N_4O_9S_2Na_2$ 566
3.		Sch.744	$C_{17}H_{15}N_4O_5SNa$ 410
4.		Sch.742 Similar C.I.652 F.D.175	$C_{17}H_{15}N_5O_7SNa$ 455
5.		C.I.652 Sch.742	$C_{20}H_{15}N_4O_5SNa$ 446
6.		C.I.224	$C_{27}H_{20}N_4O_4S$ 492
7.		C.I.224	$C_{31}H_{20}N_4OS_2$ 528
8.		C.I.132	$C_{26}H_{20}N_3O_4S_2Na$ 525
Primary Disazo Dyes (D⟨C⟩C', where C=C')			
9.		Sch.430	$C_{32}H_{20}N_4O_8S_2Na_2$ 698
10.		C.I.487 Sch.488	$C_{34}H_{24}N_4O_8S_2Na_2$ 726
11.		C.I.344 Sch.329	$C_{32}H_{20}N_4O_8S_2Na_2$ 730
12.		C.I.340 Sch.315	$C_{23}H_{15}N_5O_6SNa_2$ 535
Primary Disazo Dyes (D⟨C⟩C', where C≠C')			
13.		C.I.413 Sch.407	$C_{29}H_{18}N_4O_8SNa_2$ 612
14.		C.I.419 Sch.406	$C_{29}H_{19}N_5O_7SNa_2$ 627

TABLE VII (Cont.)

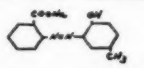
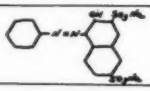
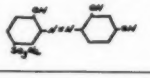
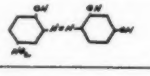
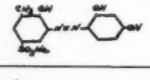
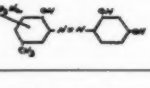
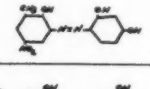
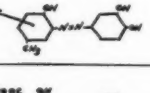
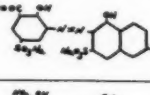
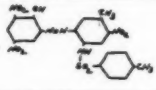
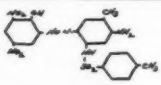
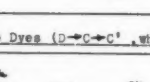
15.		C.I.431 Sch.429	$C_{32}H_{17}N_5O_9S\ Na_2$ 657
16.		C.I.432 Sch.427	$C_{32}H_{16}N_5O_{12}S_2Na_3$ 759
Secondary Disazo Dyes (D→C→C')			
17.		C.I.274 Sch.567	$C_{19}H_{12}N_4O_6S\ Na_2$ 470
18.		C.I.275 Sch.562	$C_{22}H_{16}N_4O_4S\ Na$ 454
19.		C.I.283 Sch.574	$C_{24}H_{19}N_4O_4S\ Na$ 482
20.		C.I.261 Sch.547	$C_{24}H_{19}N_4O_4S\ Na$ 482
21.		C.I.256 Sch.544	$C_{24}H_{20}N_5O_3S\ Na$ 481
22.		C.I.259 Sch.543	$C_{24}H_{19}N_4O_4S\ Na$ 482
23.		C.I.262 Sch.548	$C_{24}H_{18}N_4O_7S_2Na_2$ 584
24.		C.I.257 Sch.545	$C_{26}H_{24}N_5O_3S\ Na$ 509
25.		C.I.264	$C_{26}H_{18}N_4O_7S_2Na_2$ 612

Red: In Table VII, twenty-five red chrome azo combinations are given. The molecular weight range is 410 to 759, with 68 per cent lying between 400-600. All have one or more sulfonic groups. Eight of the twenty-five are monazo dyes, eight are primary disazo dyes, nine are secondary disazo dyes. In addition three are pyrazolone chrome azo dyes.

Bordeaux: In Table VIII fall twelve bordeaux combinations. The molecular weight range is 275 to 614, with nearly sixty per cent lying between 275 and 350. One-third of all bordeaux colors have molecular weights between 275 and 289. All but one are simple monazo dyes, the exception being a secondary disazo. All but three contain sulfonic groups.

TABLE VIII

Bordeaux Chrome Azo Dyes

Monazo Dyes (D→C)			Emperical Formula Molecular Weight
1.		C.I.212 Sch.251	$C_{17}H_{11}N_2O_3Na$ 278
2.		C.I.216 Sch.253	$C_{17}H_9N_2O_9S_2Na_3$ 518
3.		C.I.168 Sch.232	$C_{12}H_9N_2O_6S\ Na$ 332
4.		F.D.175	$C_{12}H_9N_3O_5$ 275
5.		F.D.175 Similar C.I.173 Sch.238	$C_{13}H_{11}N_2O_6S\ Na$ 346
6.		F.D.175 Similar C.I.173 Sch.238	$C_{13}H_{11}N_2O_6S\ Na$ 346
7.		F.D.175	$C_{13}H_{11}N_3O_5$ 289
8.		F.D.175	$C_{13}H_{11}N_3O_5$ 289
9.		Sch.259	$C_{17}H_9N_2O_{10}S_3Na_3$ 614
10.		C.I.107	$C_{20}H_{16}N_6O_7S$ 516
11.		Sch.136	$C_{20}H_{18}N_6O_7S$ 466
Secondary Disazo Dyes (D→C→C', where C≠C')			
12.		C.I.341 Sch.313	$C_{23}H_{16}N_4O_7S\ Na_2$ 536

Brown: In Table IX are twenty-eight brown chrome azo colors. The molecular weight range is 246 to 1082 with nearly seventy per cent lying between 300 and 500, and an additional ten per cent between 246 and 300. Over half are monazo colors, many being made from picramic acid. Four are primary disazo dyes, one a secondary disazo dye, and two are tetrakisazo dyes.

Green: In Table X are given fifteen green chrome azo dyes. The molecular weight range is 353 to 807. Two-thirds of this group have molecular weights between 400 and 600. All but two have sulfonic groups. More than half are monazo colors, forty per cent are secondary disazos, and there is one trisazo dye.

TABLE IX

Brown Chrome Azo Dyes

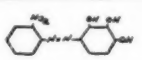
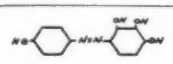
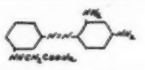
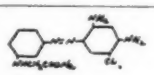
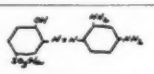
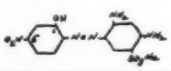
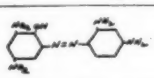
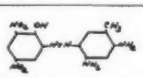
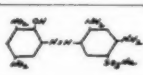
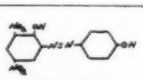
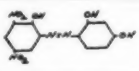
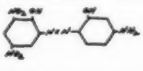
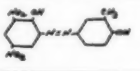
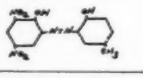
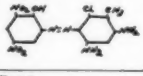
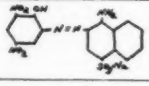
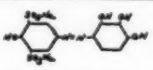
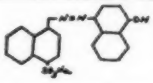
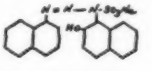
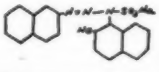
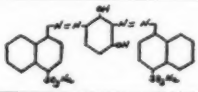
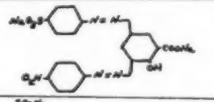
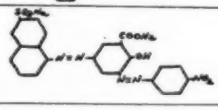
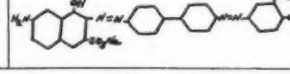
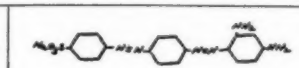
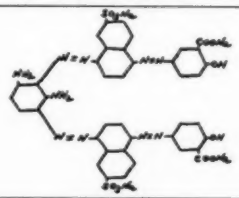
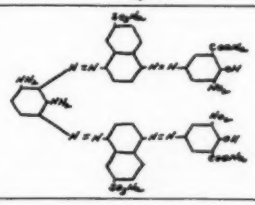
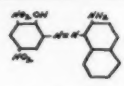
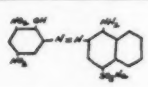
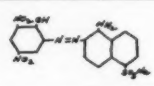
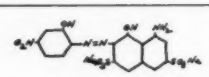
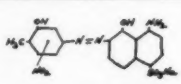
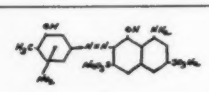
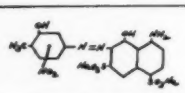
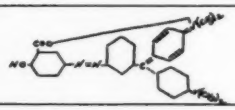
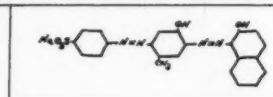
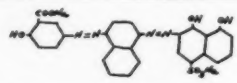
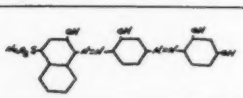
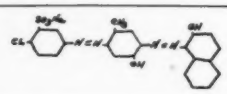
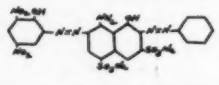
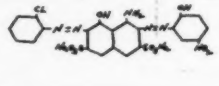
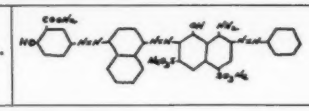
	Monazo Dyes (D→C)		Emperical Formula Molecular Weight
1.		Sch.56	$C_{12}H_9N_3O_5$ 275
2.		C.I.95 Sch.131	$C_{12}H_{10}N_2O_4$ 245
3.		C.I.214	$C_{17}H_{12}N_2O_5$ 292
4.		C.I.101 Sch.136	$C_{14}H_{14}N_5O_2Na$ 307
5.		C.I.101 Sch.136	$C_{19}H_{17}N_5O_2ClNa$ 341.5
6.		C.I.167 Sch.231	$C_{12}H_{11}N_4O_4SNa$ 330
7.		C.I.98 Sch.134	$C_{12}H_{10}N_5O_6SNa$ 375
8.		C.I.101 Sch.136	$C_{12}H_{10}N_6O_5$ 318
9.		C.I.101 Sch.136	$C_{13}H_{12}N_6O_5$ 332
10.		C.I.105 Sch.145	$C_{12}H_9N_4O_7Na$ 388
11.		C.I.103 Sch.140	$C_{12}H_7N_4O_6$ 304
12.		C.I.103 Sch.143	$C_{12}H_8N_4O_7$ 320
13.		C.I.106 Sch.144	$C_{12}H_9N_5O_6$ 319
14.		C.I.103 Sch.141	$C_{13}H_{10}N_4O_6$ 318
15.		C.I.104 Sch.142	$C_{13}H_{10}N_4O_6$ 318
16.		C.I.101 Sch.136	$C_{13}H_{11}N_4O_5Cl$ 366.5
17.		C.I.108 Sch.146	$C_{16}H_{10}N_5O_7SNa$ 455
18.		C.I.171 Sch.236	$C_{12}H_8N_2O_{10}S_2Na_2$ 450
19.		C.I.175 Sch.205	$C_{20}H_{13}N_2O_4SNa$ 400
20.		C.I.83 Sch.116	$C_{20}H_{14}N_3O_4SNa$ 415
21.		C.I.94 Sch.128	$C_{20}H_{14}N_3O_4SNa$ 415
	Primary Disazo Dyes (C, where D=D')		
22.		C.I.235 Sch.296	$C_{24}H_{16}N_4O_8S_2Na_2$ 622
	Primary Disazo Dyes (C, where D≠D')		
23.		C.I.238 Sch.304	$C_{19}H_{11}N_5O_7SNa_2$ 505
24.		F.D.175	$C_{23}H_{13}N_5O_8SNa_2$ 565
	Primary Disazo Dyes (D , where C≠C')		
25.		C.I.420	$C_{29}H_{19}N_5O_7SNa_2$ 627
	Secondary Disazo Dyes (D→C→C', where C≠C')		
26.		C.I.273	$C_{18}H_{15}N_6O_3SNa$ 418
	Tetrakisazo Dyes (C'', where D=D', C=C', C≠C'')		
27.		C.I.618 Sch.693	$C_{40}H_{24}N_{10}O_{12}S_2Na_4$ 992
28.		C.I.618	$C_{40}H_{22}N_{12}O_{16}S_2Na_4$ 1082

TABLE X

Green Chrome Azo Dyes

	Monazo Dyes (D→C)		Emperical Formula Molecular Weight
1.		C.I.102 Sch.139	$C_{16}H_{11}N_5O_5$ 353
2.		C.I.108 Sch.146	$C_{16}H_{10}N_5O_8S\ Na$ 455
3.		C.I.102 F.D.176	$C_{16}H_{10}N_5O_8S\ Na$ 455
4.		C.I.99 Sch.135	$C_{16}H_{10}N_4O_{10}S_2Na_2$ 528
5.		F.D.176	$C_{17}H_{13}N_4O_7S\ Na$ 440
6.		F.D.176	$C_{17}H_{12}N_4O_{10}S_2Na_2$ 542
7.		F.D.175	$C_{17}H_{12}N_4O_{10}S_2Na_2$ 542
8.		C.I.675	$C_{30}H_{23}N_4O_3$ 598
	Secondary Disazo Dyes (D→C→C')		
9.		C.I.292 Sch.583	$C_{23}H_{17}N_4O_5S\ Na$ 484
10.		C.I.302 Sch.615	$C_{27}H_{16}N_4O_8S\ Na_2$ 602
11.		C.I.292	$C_{22}H_{16}N_4O_7S\ Na$ 402
12.		F.D.176 Similar C.I.292 Sch.583	$C_{23}H_{15}N_4O_5S\ NaCl$ 518.5
	Secondary Disazo Dyes (D→C←D')		
13.		C.I.245 Sch.302	$C_{22}H_{18}N_7O_8S_2Na_2$ 677
14.		F.D.176	$C_{22}H_{18}N_6O_{10}S_2Na_2Cl$ 666.5

	Trisazo Dyes (D→C→C'←D')		
15.		C.I.531 Sch.622	$C_{33}H_{20}N_7O_{10}S_2Na_3$ 807

Violet: In Table XI are eleven violet chrome azo combinations. The range of molecular weight is 309 to 620. All are sulfonic acids. Most are monazo dyes, the remainder being secondary disazos.

Blue: In Table XII eleven blue chrome azo dyes are listed. Their molecular weight range is 423 to 614 with most lying between 450-600. All contain sulfonic groups, usually two in number. All are monazo dyes.

Black: In Table XIII are grouped the very important black chrome azo dyes, forty in number, with a molecular weight 380 to 790. Ninety per cent are of a molecular weight 400 to 700. All are sulfonic acids, and all are sodium salts thereof. More than half are monazo dyes. One-eighth are primary disazos. Eleven are secondary disazo dyes.

TABLE XI

Violet Chrome Azo Dyes

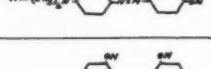
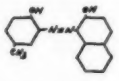
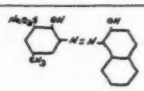
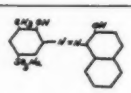
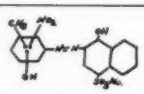
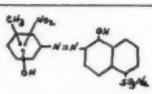
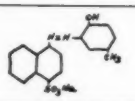
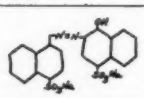
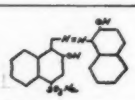
	Monazo Dyes (D→C)		Emperical Formula Molecular Weight
1.		C.I.58 Sch.102	$C_{14}H_{15}N_3O_3Cl$ 309.5
2.		C.I.169 Sch.233	$C_{16}H_{14}N_2O_5S\ Na$ 366
3.		C.I.173 Sch.238	$C_{17}H_{13}N_2O_5S\ Na$ 380
4.		F.D.175 Similar Sch.233 Sch.238	$C_{17}H_{13}N_2O_5S\ Na$ 380
5.		F.D.175	$C_{17}H_{12}N_3O_7S\ Na$ 425
6.		F.D.175	$C_{17}H_{12}N_3O_7S\ Na$ 425
7.		C.I.174 Sch.204	$C_{17}H_{13}N_2O_4S\ Na$ 364
8.		C.I.179 Sch.208	$C_{20}H_{12}N_2O_7S_2Na_2$ 502
9.		Sch.243	$C_{20}H_{13}N_2O_5S\ Na$ 416

TABLE XI (Cont.)

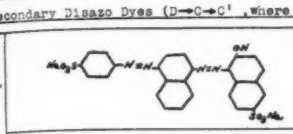
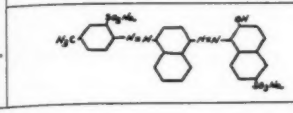
	Secondary Disazo Dyes (D→C→C', where C≠C')		
10.		C.I.293 Sch.579	$C_{26}H_{16}N_4O_7S_2Na_2$ 606
11.		C.I.298	$C_{27}H_{18}N_4O_7S_2Na_2$ 620

TABLE XII

Blue Chrome Azo Dyes

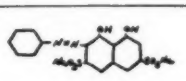
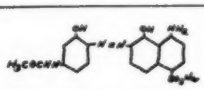
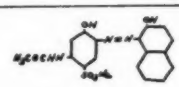
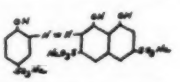
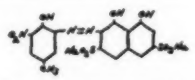
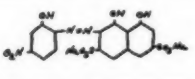
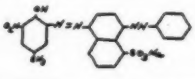
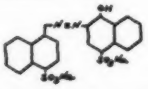
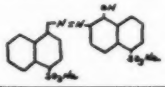
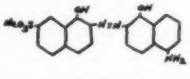
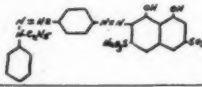
	Monazo Dyes (D→C)		Emperical Formula Molecular Weight
1.		C.I.29 Sch.44	$C_{16}H_{10}N_2O_8S_2Na_2$ 468
2.		F.D.176	$C_{18}H_{15}N_4O_6SNa$ 438
3.		F.D.176	$C_{18}H_{14}N_3O_6SNa$ 423
4.		F.D.176	$C_{16}H_9N_3O_{12}S_3Na_3$ 586
5.		F.D.176	$C_{17}H_{11}N_3O_{11}S_2Na_2$ 543
6.		Sch.137	$C_{16}H_9N_3O_{11}S_2Na_2$ 529
7.		C.I.96 Sch.147	$C_{23}H_{17}N_4O_6SNa$ 500
8.		C.I.179 Sch.208	$C_{20}H_{12}N_2O_7S_2Na_2$ 502
9.		C.I.180 Sch.209	$C_{20}H_{12}N_2O_7S_2Na_2$ 502
10.		F.D.176	$C_{20}H_{14}N_3O_6SNa$ 431
11.		C.I.125 Sch.164	$C_{25}H_{20}N_4O_7S_2Na_2$ 614

TABLE XIII

Black Chrome Azo Dyes

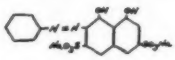
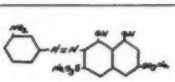
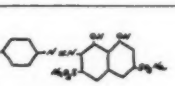
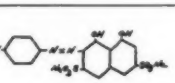
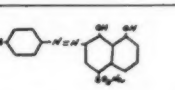
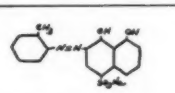
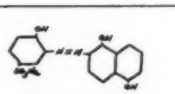
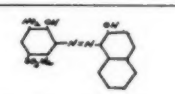
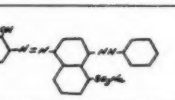
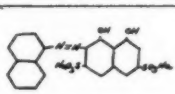
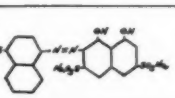
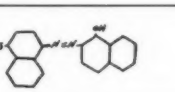
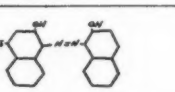
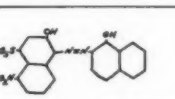
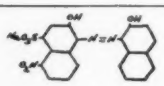
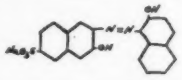
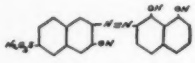
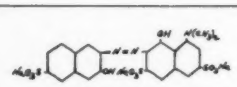
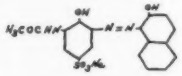
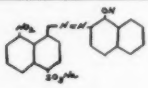
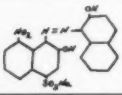
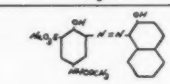
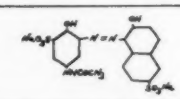
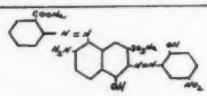
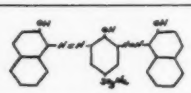
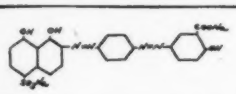
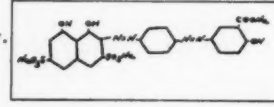
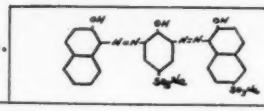
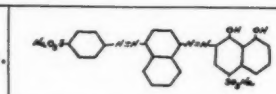
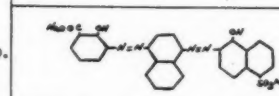
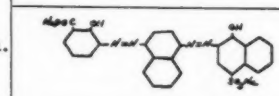
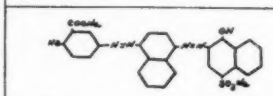
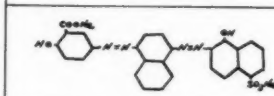
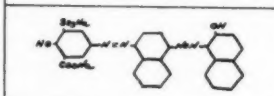
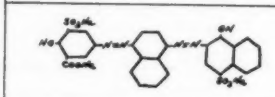
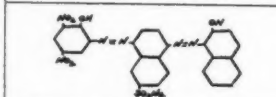
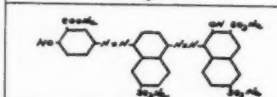
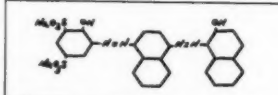
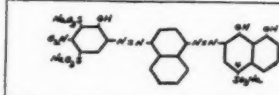
	Monazo Dyes (D→C)		Emperical Formula Molecular Weight
1.		C.I.29 Sch.44	$C_{16}H_{10}N_2O_8S_2Na_2$ 468
2.		Sch.67	$C_{16}H_9N_3O_{10}S_2Na_2$ 513
3.		C.I.45 Sch.67	$C_{16}H_9N_3O_{10}S_2Na_2$ 513
4.		C.I.56 Sch.107	$C_{18}H_{13}N_3O_9S_2Na_2$ 525
5.		C.I.153 Sch.190	$C_{16}H_{10}N_2O_8S_2Na_2$ 468
6.		C.I.66 Sch.80	$C_{17}H_{12}N_2O_5SNa$ 380
7.		C.I.170 Sch.234	$C_{16}H_{11}N_2O_6SNa$ 382
8.		C.I.172 Sch.237	$C_{16}H_{10}N_2O_7SNa$ 411
9.		C.I.96 Sch.147	$C_{23}H_{17}N_4O_6SNa$ 500
10.		C.I.90 Sch.124	$C_{20}H_{12}N_2O_8S_2Na_2$ 518
11.		C.I.188 Sch.216	$C_{20}H_{11}N_2O_{11}S_3Na_3$ 620
12.		C.I.201 Sch.239	$C_{20}H_{13}N_2O_5SNa$ 416
13.		C.I.202 Sch.240	$C_{20}H_{13}N_2O_5SNa$ 416
14.		C.I.203 Sch.241	$C_{20}H_{12}N_3O_7SNa$ 461

TABLE XIII (Cont.)

15.		C.I.204 Sch.242	$C_{20}H_{12}N_2O_7S$ Na 461
16.		C.I.206 Sch.249	$C_{20}H_{13}N_2O_5S$ Na 416
17.		C.I.206 Sch.249	$C_{20}H_{13}N_2O_6S$ Na 432
18.		C.I.206 Sch.249	$C_{22}H_{16}N_3O_{11}S_3Na_3$ 663
19.		F.D.178	$C_{18}H_{14}N_2O_6S$ Na 423
20.		F.D.177	$C_{20}H_{12}N_2O_7S$ Na 461
21.		F.D.177	$C_{20}H_{12}N_2O_7S$ Na 461
22.		F.D.178	$C_{18}H_{14}N_2O_6S$ Na 423
23.		F.D.178	$C_{18}H_{14}N_2O_7S$ Na 471
Primary Disazo Dyes ($D \diagdown C \diagup D$, where $D \neq D'$)			
24.		F.D.178	$C_{23}H_{14}N_6O_7S$ Na_2 576
Primary Disazo Dyes ($D \diagdown C \diagup C'$, where $C = C'$)			
25.		C.I.336 Sch.332	$C_{26}H_{17}N_4O_6S$ Na 536
Primary Disazo Dyes ($D \diagdown C \diagup C'$, where $C \neq C'$)			
26.		C.I.342 Sch.316	$C_{23}H_{14}N_4O_8S$ Na_2 552
27.		C.I.342 Sch.316	$C_{23}H_{13}N_4O_{11}S_3Na_3$ 654
28.		C.I.337 Sch.323	$C_{26}H_{16}N_4O_7S_2Na_2$ 638
Secondary Disazo Dyes ($D \rightarrow C \rightarrow C'$, where $C \neq C'$)			
29.		C.I.295	$C_{26}H_{16}N_4O_8S_2Na_2$ 622
30.		C.I.299 Sch.614	$C_{27}H_{16}N_4O_7S$ Na_2 586
31.		C.I.299 Sch.614	$C_{27}H_{16}N_4O_7S$ Na_2 586
32.		C.I.299 Sch.614	$C_{27}H_{16}N_4O_7S$ Na_2 586
33.		C.I.299 Sch.614	$C_{27}H_{16}N_4O_7S$ Na_2 586
34.		Sch.612	$C_{27}H_{16}N_4O_7S$ Na_2 586
35.		C.I.301 Sch.612	$C_{27}H_{16}N_4O_{10}S_2Na_2$ 688
36.		C.I.272 Sch.577	$C_{26}H_{16}N_6O_7S$ Na 610
37.		C.I.303 Sch.616	$C_{27}H_{14}N_4O_{13}S_3Na_4$ 790
38.		F.D.178	$C_{26}H_{16}N_4O_8S_2Na_2$ 622
39.		F.D.178	$C_{26}H_{14}N_4O_{10}S_3Na_3$ 785

V. MOLECULAR WEIGHT AND EMPIRICAL FORMULAE OF CHROME AZO DYESTUFFS

In Table XIV the chrome azo dyestuffs are listed according to their molecular weights. The corresponding empirical formula, color, Colour Index Number and Schultz Number of each is given. Those preceded by an asterisk are not given in the AATCC Handbook for 1941.

The following points can be noted by scanning the table below. The molecular weights range from 246 to 1082. All chrome azo colors contain carbon, hydrogen, nitrogen, and oxygen; most are sodium salts; a large proportion

contain sulfur chiefly as the sulfonic acid; only five contain chlorine. Several are isomers. It will be noted that some duplication occurs, especially in the blue, violet, and black colors. Certain chrome azo colors in light and medium heavy shades give blue or violet while the same color in very deep shades yield blacks. These blue-blacks and violet-blacks are listed both as blue or violet and black. Under the color is given a cross reference to a compound graphically shown in Tables IV to XIII inclusive.

TABLE XIV

Chrome Azo Dyestuffs Listed According to Their Molecular Weight

Mol. Wt.	Emperical Formula C	H	N	O	S	Na	Cl	Color	C.I. No.	Schultz No.	
*246	12	10	2	4				Br.2	95	131	
*272	14	12	2	4				Y.6	112	152	
*275	12	9	3	5				Br.1	—	56	
*275	12	9	3	5				Bdx.4	—	—	Fierz David 175
*278	14	11	2	3		1		Y.4	67	81	
*278	14	11	2	3		1		Bdx.1	212	251	
286	15	14	2	4				Y.7	122	157	
*286	14	10	2	5				Y.8	213	255	
*286	14	10	2	5				Y.9	218	257	
287	13	9	3	5				Y.1	36	55	
287	13	9	3	5				Y.2	40	66	
*289	13	11	3	5				Bdx.7	—	—	Fierz David 175
*289	13	11	3	5				Bdx.8	—	—	Fierz David 175
*292	17	16	4	1				Y.26	638	733	
292	17	12	2	3				Br.3	214	252	
*301	14	11	3	5				Y.5	67	83	
301	14	11	3	5				Y.15	36	56	
*304	12	8	4	6				Br.11	103	140	
307	14	14	5	2		1		Br.4	101	136	
*309.5	14	16	3	3			1	V.1	58	102	
318	12	10	6	5				Br.8	101	136	
*318	13	10	4	6				Br.14	103	141	
*318	13	10	4	6				Br.15	104	142	
*319	12	9	5	6				Br.13	106	144	
*320	12	8	4	7				Br.12	103	143	
321	15	12	3	4		1		Y.3	52	109	
*325	13	8	3	6		*1		Y.19	37	57	
*325	13	8	3	6		1		Y.20	41	68	
*329	19	14	3	2		1		Y.21	217	256	
330	12	11	5	4	1	1		Br.6	167	231	
332	13	12	6	5				Br.9	101	136	
332	12	9	2	6	1	1		Bdx.3	168	232	
334	19	14	2	4				Y.23	110	113	
341.5	14	13	5	2		1	1	Br.5	101	136	
346	14	8	2	6		2		Y.10	219	258	
*346	13	11	2	6	1	1		Bdx.5	—	—	Fierz David 175
*346	13	11	2	6	1	1		Bdx.6	—	—	Fierz David 175
*353	16	11	5	5				G.1	102	139	
*364	17	13	2	4	1	1		V.7	174	204	
366	16	11	2	5	1	1		V.2	169	233	
366.5	13	11	6	5			1	Br.16	101	136	
375	12	10	5	6	1	1		Br.7	98	134	
*380	17	13	2	5	1	1		V.3	173	238	
*380	17	13	2	5	1	1		V.4	—	—	Fierz David 175
*380	17	13	2	5	1	1		Bk.6	66	80	
382	16	11	2	6	1	1		Bk.7	170	234	
*388	12	9	6	8		1		Br.10	105	145	
*389	13	8	3	8	1	1		O.1	157	167	
400	20	13	2	4	1	1		Br.19	175	205	
*402	22	15	4	7	1	1		G.11	292	583	
*403	14	10	3	8	1	1		O.2	157	167	
*410	17	15	4	5	1	1		R.3	—	744	
411	16	10	3	7	1	1		Bk.8	178	237	
*415	20	14	3	4	1	1		Br.20	83	116	
*415	20	14	3	4	1	1		Br.21	94	128	
416	17	10	2	6	1	2		Y.11	195	230	
416	17	10	2	6	1	2		Y.12	195	230	
416	17	10	2	6	1	2		Y.13	195	230	
*416	20	13	2	5	1	1		V.9	—	243	
416	20	13	2	5	1	1		Bk.12	201	239	
416	20	13	2	5	1	1		Bk.13	202	240	
*416	20	13	2	5	1	1		Bk.16	206	249	
*418	18	15	6	3	1	1		Br.26	273	561	
*423	18	14	3	6	1	1		B.3	—	—	Fierz David 176
*423	18	14	3	6	1	1		Bk.19	—	—	Fierz David 178
*423	18	14	3	6	1	1		Bk.22	—	—	Fierz David 178
*425	17	12	3	7	1	1		V.5	—	—	Fierz David 175
*425	17	12	3	7	1	1		V.6	—	—	Fierz David 175
430	18	12	2	6	1	2		Y.16	195	230	
430	18	12	2	6	1	2		Y.17	195	230	
430	18	12	2	6	1	2		Y.18	195	—	
*431	20	14	3	5	1	1		B.10	—	—	Fierz David 176
432	20	13	2	6	1	1		Bk.17	206	249	
*438	18	15	4	6	1	1		B.2	—	—	Fierz David 176
*440	17	13	4	7	1	1		G.5	—	—	Fierz David 176
*446	17	12	4	6	1	2		Y.27	651	740	
446	20	15	4	5	1	1		R.5	652	742	
*450	12	8	2	10	2	2		Br.18	171	236	
454	22	15	4	4	1	1		R.18	275	562	
*455	16	10	5	8	1	1		G.2	108	146	
*455	16	10	5	8	1	1		G.3	102	139	Fierz David 176
455	17	14	5	7	1	1		R.4	652	742	Fierz David 175
*455	16	10	5	8	1	1		Br.17	108	146	
461	20	12	3	7	1	1		Bk.14	203	241	
461	20	12	3	7	1	1		Bk.15	204	242	
*461	20	12	3	7	1	1		Bk.20	—	—	Fierz David 177
*461	20	12	3	7	1	1		Bk.21	—	—	Fierz David 177
468	16	10	2	8	2	2		B.1	29	44	
468	16	10	2	8	2	2		Bk.1	29	44	
468	16	10	2	8	2	2		Bk.5	153	190	
470	19	12	4	6	1	2		Y.22	109	112	
470	19	12	4	6	1	2		O.7	274	567	
470	19	12	4	6	1	2		R.17	274	567	
*470	25	20	4	6	1	1		Y.38	237	310	
*471	26	18	5	3		1		Y.28	229	260	
*471	18	15	3	9	1	1		Bk.23	—	—	Fierz David 178
*476	25	17	4	5		1		O.4	412	401	
.481	24	20	5	3	1	1		R.21	256	544	
*482	24	19	4	4	1	1		R.19	283	574	
482	24	19	4	4	1	1		R.20	261	547	
*482	24	19	4	4	1	1		R.22	259	543	
484	23	17	4	5	1	1		G.9	292	583	
*486	20	18	6	7	1			Bdx.11	—	138	
*492	24	20	4	4	2			R.6	224	275	
*496	17	10	2	9	2	2		R.1	124	163	
*500	23	17	4	6	1	1		B.7	96	147	
*500	23	17	4	6	1	1		Bk.9	96	147	
502	20	12	2	7	2	2		B.8	179	208	
502	20	12	2	7	2	2		B.9	180	209	
502	20	12	2	7	2	2		V.8	179	208	
505	19	11	5	8	1	2		Br.23	238	304	
*509	26	24	5	3	1	1		R.24	257	545	
*510	27	18	4	7				Y.39	237	310	
*513	21	13	3	6	2	2		Y.24	223	281	
*513	16	9	3	10	2	2		Bk.2	45	67	
*513	16	9	3	10	2	2		Bk.3	45	67	
*516	20	16	6	9	1			Bdx.10	107	138	
518	17	9	2	9	2	3		Y.14	197	226	
518	17	9	2	9	2	3		Bdx.2	216	253	
518	20	12	2	8	2	2		Bk.10	90	124	
*518.5	23	16	4	5	1	1	1	G.12	—	—	Fierz David 176
*525	26	20	3	4	2	1		R.8	132	268	
525	18	13	3	9	2	2		Bk.4	56	107	
*526	29	19	4	5		1		Y.37	414	402	
*528	16	10	4	10	2	2		G.4	99	135	
*528	31	20	4	1	2			R.7	224	275	
*529	16	9	3	11	2	2		B.6	100	137	
*535	23	15	5	6	1	2		R.12	340	315	
*536	23	14	4	7	1	2		Bdx.12	341	313	
536	26	17	4	6	1	1		Bk.25	336	332	
*539	26	15	5	6		2		Y.36	445	531	
*540	27	18	4	6		2		Y.31	—	442	
*542	17	12	4	10	2	2		G.6	—	—	Fierz David 176
*542	17	12	4	10	2	2		G.7	—	—	Fierz David 176
*543	17	11	3	11	2	2		B.5	—	—	Fierz David 176
*552	23	14	4	8	1	2		Bk.26	342	316	
558	26	16	4	6	1	2		Y.32	343	330	
*565	23	13	5	8	1	2		Br.24	—	—	Fierz David 175

TABLE XIV (Cont.)

Mol. Wt.	Emperical Formula C	H	N	O	S	Na	Cl	Color	C.I. No.	Schultz No.	
566	20	16	4	9	2	2		R.2	57	110	
*576	23	14	6	9	1	2		Bk.24	—	—	Fierz David 178
584	24	18	4	7	2	2		R.23	262	548	
*586	16	9	2	12	3	3		B.4	—	—	Fierz David 176
586	27	16	4	7	1	2		Bk.30	299	614	
586	27	16	4	7	1	2		Bk.31	299	614	
586	27	16	4	7	1	2		Bk.32	299	614	
586	27	16	4	7	1	2		Bk.33	299	614	
*586	27	16	4	7	1	2		Bk.34	301	612	
*598	30	28	4	3				G.8	675	773	
602	27	16	4	8	1	2		G.10	302	615	
*606	26	16	4	7	2	2		V.10	293	579	
*610	26	15	6	9	1	1		Bk.36	272	577	
611	29	19	5	6	1	2		O.5	415	404	
*611	29	19	5	6	1	2		O.6	416	406	
*612	29	18	4	7	1	2		R.13	413	407	
*612	26	22	4	7	2	2		R.25	264	550	
*614	17	9	2	13	3	3		Bdx.9	—	259	
*614	25	20	4	8	2	2		B.11	125	164	
*620	27	18	4	7	2	2		V.11	298	589	
*620	20	11	2	11	3	3		Bk.11	188	216	
622	26	16	4	8	2	2		Br.22	235	296	
*622	26	16	4	8	2	2		Bk.29	295	581	
*622	26	16	4	8	2	2		Bk.38	—	—	Fierz David 178
627	29	19	5	7	1	2		R.14	419	406	
627	29	19	5	7	1	2		Br.25	420	412	
*638	26	16	4	9	2	2		Bk.28	337	323	
*646	28	16	4	6	3	2		Y.25	223	281	
*654	23	13	4	11	2	3		Bk.27	342	316	
657	29	17	5	9	1	2		S.1	431	429	
657	29	17	5	9	1	2		R.15	431	429	
*663	22	16	3	11	3	3		Bk.18	206	249	
*666.5	22	13	6	10	2	2	1	G.14	—	—	Fierz David 176
*673	26	14	5	11	1	3		Y.35	433	428	
*677	22	13	7	12	2	2		G.13	245	302	
685	31	21	5	9	1	2		S.2	431	429	
*688	27	15	4	10	2	3		Bk.35	301	612	
698	32	20	4	8	2	2		R.9	443	430	
726	34	24	4	8	2	2		R.10	487	488	
730	26	14	4	12	2	4		Y.29	442	432	
*730	32	20	4	8	3	2		R.11	344	329	
*734	26	18	4	12	2	4		Y.34	—	331	
*758	28	18	4	12	2	4		Y.30	442	433	
*759	29	16	5	12	2	3		R.16	432	427	
*762	26	14	4	12	3	4		Y.33	—	331	
*766	41	30	6	10				Y.40	603	686	
*785	26	14	5	14	3	3		Bk.39	—	—	Fierz David 178
*790	27	14	4	13	3	4		Bk.37	303	616	
*798	27	17	6	9	5	3		O.3	222	274	
*807	33	20	7	10	2	3		G.15	531	622	
*992	40	24	10	12	2	4		Br.27	618	693	
*1082	40	22	12	16	2	4		Br.28	618	693	

CONCLUSION

The above discussion embraces most of the popular commercial chrome azo colors as well as some of the lesser known members.

By close inspection of the chrome azo dyestuffs it can be seen that several weak points exist. The great strength of the chrome azo colors is largely in dark blues, violets, blacks, browns and bordeaux. This is especially so when fulling, and potting characteristics are under consideration. The yellows are mostly reddish, or, at best, dirty greenish. The few abnormal chrome azo yellows made from acetoacetic ester derivatives are clean and green, but leave much wanting in the matter of light fastness as compared to the other chrome azo colors. There are but few popular reds, especially bright reds. The brighter blues are largely oxazine or thiazine and are not chrome azo colors but colors of another type developed with chrome. These latter dyestuffs are bright but of not too great lightfastness. The greens are being improved. These, with the yellows and dull reds are of great importance in the production of khaki, olive drab, and other similar military shades.

The trend in chrome azo colors is toward production of colors with multi chromable groups as can be readily ascertained by inspection of the patents issued in the past few years.

Some work has been done and is being done on the insoluble azo chrome intermediates with moderate success. These products are either water soluble or dispersible in themselves, but give water insoluble but dispersible colors when coupled to appropriate secondary intermediates. With the rapid growth of new wetting and dispersing agents, as well as newer types of emulsions, these types may upset preconceived ideas as to the necessity for water solubility in chrome azo colors.

New intermediates introduced in the pigment field such as dichlorbenzidine and its disulfo acid as well as beta hydroxy naphthoic acid and its sulfo acid give pleasing browns when afterchromed on wool. Further work in this field is indicated. Many recent patents show the trisazo and tetrakisazo dye classes are being studied.

The abnormal chrome azo types as well as those of the simpler metachrome process chrome azo colors are growing in popularity and will probably continue to do so, largely because of the ease, quickness of application and other labor saving considerations. The dyestuff makers have long advocated the metachrome process as well as the abnormal types, and are developing these classes, overcoming past difficulties in application and properties.

The future in chrome azo colors will emphasize ease and rapidity of application and greater fastness properties—all advantages to the user—at the expense of greater complexity in chemical structure—an advantage, too, to the dyestuff maker in that he may serve the consumer better.

* * * *

The author wishes to express his appreciation to the Aridye Corporation for permission to publish this article.

* * * *

ERRATA

Table II. Neolan Blue B diazo component has SO_3H para to azo group.

Table IV. Y.15 COOH in place of COONa.

Table VII. R.3 Double Bond between 2 and 3 positions, pyrazolone nucleus.
R.5 CH_3 on 3 position, OH on 5 position, pyrazolone nucleus.
R.8 CH_3 on position ortho to N, first nucleus.

Table VIII. Bdx.2 COONa on position ortho to azo, first nucleus.

Table IX. Br.2 Molecular weight 246 instead of 275.
Br.3 Emperical formula $C_{17}H_{12}N_2O_3$.

Table XIII. Bk.12 OH ortho to azo, first nucleus.
Bk.20 OH ortho to azo, first nucleus.
Bk.28 Emperical Formula $C_{26}H_{16}N_4O_9S_2Na_2$.

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FEBRUARY 1, 1943

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Members should notify the **Secretary** immediately of all address changes.

INTERSECTIONAL CONTEST

THE council, meeting in Boston, decided to hold another inter-sectional contest. Although it requires a lot of work to produce an intersectional paper, several of those last year were very helpful both to our own research council and to the war effort of the entire textile industry. Furthermore, these contests form another bond between the different sections which is particularly valuable now that our national meetings are discontinued for the duration. The papers this year will be given at the Fall meet-

ing of the New York section—the date to be announced later.

Two innovations have been made in the judging of the papers. First, the judges will be given perhaps a month and certainly more than the usual 24 hours which they have had in the past, to decide which are the prize winning papers. Secondly, the scale of judging has been shifted to place more emphasis on the practical value of the paper to our industry. Thus, in 1943 the judges will allow 30 per cent for the paper's practical value, 30 per cent for its strictly scientific value and 30 per cent for originality, with only 10 per cent for presentation. This will eliminate any extensive exhibits but will permit charts, slides, etc. as usual. The papers must be short enough so that they can be read in 20 minutes.

Local sections have been advised to appoint chairmen of contest paper committees and to select judges.

KENNETH H. BARNARD, *Chairman,*
Inter-sectional Contest Committee.

MEETING, PIEDMONT SECTION OFFICERS

PROBLEMS caused by transportation difficulties and gasoline restrictions was one of the principal topics discussed by the officers of the Piedmont Section meeting in Charlotte, January 10.

C. Norris Rabold, Chairman, and chemist for the Union Bleachery, Greenville, South Carolina, presided. Other officers present included: Leland G. Atkins, Secretary, Southern Dyestuff Corporation, Charlotte, North Carolina; Wyss L. Barker, Treasurer, National Aniline Division, Allied Chemical and Dye Corporation, Charlotte, North Carolina; A. Henry Gaede, Councilor, Laurel Soap Manufacturing Company, Charlotte, North Carolina; T. W. Church, Jr., Councilor, Highland Park Manufacturing Company, Charlotte, North Carolina; Peter S. Gilchrist, Committeeman, Charlotte Chemical Laboratories, Charlotte, North Carolina.

This meeting was also honored by the presence of Thomas R. Smith, President of the National Body, and Superintendent of the Wiscassett Mills Yarn Dyeing Division, Albemarle, North Carolina.

The Piedmont Section ordinarily holds four meetings each year, but due to the unusual conditions brought about by war emergencies, rationing, and other problems confronting the industry it was decided to hold only three meetings in 1943. It is planned to hold the first meeting in Greenville, South Carolina, early in March. Greensboro, North Carolina, was selected for the second meeting in May or June. The fall meeting will be held in Charlotte, North Carolina, in October. The exact dates of the various meetings have not been decided. It was decided to dispense with all social functions, such as golf tournaments, etc., for the duration or at least until the acute problems of transportation have been solved.

The mills represented by the membership are running on such busy schedules that it was decided to hold the various meetings on Saturday evenings to permit attendance by a larger portion of the membership. The technical meetings in previous years were frequently held on Saturday afternoons to permit the discussion of a larger number of problems and new methods of interest to the membership.

The Committee plans to focus the attention of the membership on problems pertaining to the war program in all of the meetings this year.

A. R. THOMPSON, JR.,
Publicity Chairman.

MEETING, NEW BEDFORD TEXTILE SCHOOL STUDENT CHAPTER

THE New Bedford Textile School Student Chapter met on Monday, January 10, 1943 for the purpose of electing new officers and receiving new members from the Freshman class of the Chemistry, Dyeing and Finishing department.

Francis Tripp called the meeting and the officers elected from the Freshman class were those who were not likely to be called into the armed services before next year. Miss Helen E. Brooks was elected chairman and Charles T. Allen, Jr., secretary for the year 1943.

The new members welcomed into the student chapter were Charles T. Allen, Jr., Richard Leo Dufour, James A. Flanagan, L. Rene Rochefort, Harris Sederholm, Walter G. Silva, New Bedford; William L. Benson, Fairhaven; and Helen Edith Brooks, Mattapoisett.

At future meetings of the student chapter, invited speakers from the Textile Finishing industry will address the students.

Respectfully submitted,
CHARLES T. ALLEN, JR., *Secretary.*

CALENDAR OF COMING EVENTS

Meeting, Mid-West Section, Bismarck Hotel, Chicago, Ill., February 6, 1943. Speaker: J. A. Hopwood, American Viscose Corp., "Dyeing of Rayon and Kindred Problems."

Meeting, New York Section, March 5, 1943.

Meeting, Philadelphia Section, March 5, 1943.

Meeting, Northern New England Section, March 19, 1943.

General Business Meeting (in conjunction with New York Section meeting) April 16, 1943, New York City.

Council and Research Committee Meetings, April 17, 1943, New York City.

OBITUARY

EMIL F. ERNST

EMIL F. ERNST, assistant secretary and a director of the Carbic Color & Chemical Co., Inc., died on January 11th. His home was at 1138 Palisade Avenue, Palisades, N. J.

Emil F. Ernst

Mr. Ernst was born in Vienna, Austria, on March 15th, 1886, but has lived in this country since 1903, becoming a citizen in 1909. From 1904 until 1917 he was with Kalle & Co., Inc., New York. From 1917 to 1921 he was a partner in the Products Trading Co., New York, and from 1921 to 1931 he was president of the Products Color Corp., New York. He joined Carbic Color & Chemical Corp. in 1931 and at the time of his death held the position of assistant secretary and was also a director.

Mr. Ernst was an active member of the New York Section of the American Association of Textile Chemists and Colorists.

HARRY GARDNER

HARRY GARDNER, salesman and demonstrator for the National Aniline Division, Allied Chemical and Dye Corp., died at his home in Teaneck, N. J., on November 1st, 1942. He was 48 years old.

Mr. Gardner had been associated with National for the past 24 years, having joined its technical staff only one year after its formation in 1917 to devote his major attention to the hat industry.

He was an active member of the New York Section of the American Association of Textile Chemists and Colorists.

• TEXTILE ROLL COVERINGS

The Armstrong Cork Co., Lancaster, Pa., has issued a booklet entitled "Modern Textile Roll Coverings." The booklet gives a comprehensive coverage of the important facts about cots and aprons in an effort to help solve roll covering problems. There are numerous illustrations. The advantages of the various materials used in roll coverings are compared. The booklet is available upon request.

• PROMOTED TO LT. COL.

William B. Johnson, Jr., formerly an analyst at the Roanoke, Va., plant of the American Viscose Corporation, has been promoted to the grade of lieutenant-colonel. He commenced active duty in 1940 with the first of the National Guard units and subsequently attended the Command and General Staff School at Fort Leavenworth, Kan., in 1942.

• AMPLE SUPPLIES OF REPELLENT

Ample supplies of a durable water repellent finish for textiles to satisfy both military and civilian needs will be available in 1943, E. I. du Pont de Nemours & Company advised recently.

Demands by the armed forces for "Zelan" durable water repellent to treat field jackets, ski troop uniforms, parkas and other clothing for our armed forces was so great in the months after Pearl Harbor that very little was left for civilian textiles.

It is stated that fabrics treated with this chemical finish shed water, resist stains and spots, and wear longer. They retain their protective qualities through many cleanings. The chemical allows the body to "breathe," for it does not close the pores of the fabric as does a rubber or resin coating.

Children's play clothes, windbreakers, raincoats, and workers' clothes are some of the civilian garments which can be treated with this durable finish now that the chemical is again available.

• JOINS PAPER TUBE CO.

Russell A. Carroll, formerly of the Pairpoint Corp., has joined the New England Paper Tube Co., at Pawtucket, R. I., as Sales Representative in the New England area.

Mr. Carroll is a graduate of the New Bedford Textile School. He was associated with the Hercules Powder Co. in East Greenwich, R. I., as a salesman for several years. He has been connected with the Pairpoint Corp. for the past several years as Sales Engineer for the New England area, and is well known among the textile trade.

Amendment to M-103

FAR-REACHING control over dyes and organic pigments used in civilian clothing and other consumer products were announced on January 22nd by the Director General for Operations with the amendment of Order M-103 (dyestuffs and organic pigments).

In an action whose effects will be felt in the textile, leather, paper, paint, printing ink, lacquer, plastics, rubber and other industries, WPB ordered the sale and purchase of all organic dyestuffs and organic pigments for civilian use cut an average of 40 per cent below 1941 figures. The order is retroactive to January 1, 1943.

The sole exceptions are dyestuffs and organic pigments derived from vegetable sources, inorganic dyes, and organic dyes synthesized or produced from relatively non-critical materials.

Textiles and clothing will no longer be made in so many bright or dark shades as in the past. Due to restrictions on the amount of dyes available, clothing manufacturers will be required to spread their supply and the result will be lighter shades in all types of fabrics. Printed fabrics will contain a larger amount of white space than is now the case, and brightly colored prints will be less available than in the past.

Some shoes will be made in lighter shades than in the past, particularly in such colors as brown, blue and red.

Paints and lacquers may be available in less variety and, in some cases, in the lighter shades only.

This will be true also of color printing for newspapers and magazines, particularly in the restrictions on the use of more brilliant shades.

Likewise, beauty aids such as lipstick and nail polish will reflect the restrictions on use of bright and dark shares.

However, in the case of paints and lacquers, color printing and beauty aids, inorganic colors can be used as suitable substitutes.

Colored paper will be less varied and will be manufactured generally in lighter shades.

Plastics and rubber products likewise will reflect the emphasis on light colors.

The Order was made necessary by shortages of chemical materials used in extremely important phases of the war program. These materials include: Benzene, Aniline, Toluene, Phthalic Anhydride, Prenols, Cresols, Xylenols, etc.

As a result of the Order, approximately 55 million pounds of dyes—and the raw materials that go into them—will be made available for the war effort.

● DU PONT DISPLAY

Planning along consumer education lines is combined with sales appeal in this Atlantic City and Wilmington window display of Du Pont. Presenting Dan River Skytop and Spunray vat-dyed shirts grouped with U. S. Army style, tested and pre-test swatches of fabric demonstrate the fastness of vat colors offered, to washing, chlorine and sunlight.

The Order classifies dyestuffs and organic pigments into four groups. Restrictions are imposed on both the sale and purchase of these dyes, and with minor exceptions, these restrictions provide that no more dyestuffs and organic pigments may be sold or received during each quarter of this year than 15 per cent of the total amount of similar dyes sold or received in 1941 based on 1943 dollar value. The Classes are:

Class A. These include anthraquinone vat dyes appearing on List A of the Order. Such dyes cannot be sold for civilian purposes, a prohibition originally included in the order.

Class B. These include all anthraquinone vat dyes not appearing on List A. Sales and deliveries are restricted in each quarter to 15 per cent of the 1941 total sales and deliveries of Class A and B dyes. Previously, the limitation had been 17½ per cent of 1941.

Class C. Included in this class are all anthraquinone dyes other than anthraquinone vat dyes. The same 40 per cent cut in sales and deliveries is imposed, based on sales and deliveries of Class C dyes in 1941. However, deliveries up to $100 in value per quarter are allowed if 15 per cent of the total 1943 dollar value of such dyestuffs sold in 1941 is less than this amount.

Class D. These include all dyes and organic pigments not in the other three classes, but excluded are inorganic dyes, organic dyes derived from vegetable sources and those made from non-critical materials. Deliveries cannot exceed $100 in value or 15 per cent of the total 1943 dollar value of such dyestuffs sold in 1941, whichever is higher.

Exports are also controlled by the order, with the provision that Canadian exports are to be included under domestic quotas.

During 1943, dyestuff and organic pigments producers can export no more than: ¾ of one per cent of the total 1943 dollar value of dyestuffs and pigments sold in 1941, plus 17 per cent of their 1943 dollar value of dyestuffs and organic pigments sold for export in 1941 to all countries other than Canada.

In addition, their exports of Class A dyes and organic pigments in any one quarter cannot exceed ¾ of one per cent of the total 1943 dollar value of Class A dyes sold in 1941, while the total amount of Class A, B, and C dyes which can be exported cannot exceed 2 per cent of the total 1943 dollar value of those dyes sold by an individual producer in 1941.

Excepted from provisions of the order are sales to specified government agencies, Lend-Lease, sales to producers working on specified government contracts, sales for use in production of specified types of uniforms, inventory replacements when the original dyes were used in fulfillment of government contracts, sales from one producer to another, and dyes used for coloring of gasoline. Deliveries made for government orders must be certified.

Other points of the order of interest primarily to the trade include:

1. Unused export quotas can be carried over from one quarter to another for purpose of the limitations of the order. Domestic quotas cannot be carried over.
2. The restrictions apply only to the class of dyes, and there are no provisions affecting the sale of any one specific type of dye.
3. If a producer makes his own dyes and then uses them in the manufacture of a product requiring dyes, he is restricted by provisions of the order.
4. In some cases, dyes of one class are mixed with those of another. The class in which the mixture falls is determined by the class of dyes which makes up at least 90 per cent of the mixture. This will permit the use of shading colors in manufacturing and distribution of dyes.
5. Previous provisions in the order relating to restrictions on the use of meta-toluylene diamine, anthraquinone, and annato extracts remain unchanged.

In connection with this order, provision of M-53 relating to inorganic pigments used in printing ink were put under M-103.

Restrictions on organic pigments for printing ink now covered by M-103 are found under Class D with one important exemption. Lithol red, made from naphthalene and widely used in the printing industry, is not restricted.

The order defines "1943 dollar value" to mean the dollar value computed from the domestic consumers contract sales price as of January 1, 1943.

● DECORATED FOR GALLANTRY

John H. Powers, formerly an assistant chemist in the laboratory of American Aniline Products, Inc., at Lock Haven Works, was recently decorated for gallantry in action at the battle of Midway. Mr. Powers' parents have just received the decoration of the Silver Star which was awarded to their son. Sergeant Powers, who has now been in the army for 2½ years, has been serving continuously in the Pacific since the outbreak of the war.

● NEW YORK ATLAS OFFICE

Fred Schlayer, New York representative of Atlas Electric Devices Co., Inc., is now located at 463 Broome St., New York City. Telephone numbers remain as before: CAnal 6-5133 and 5134.

• DCAT ANNUAL DINNER

Victor E. Williams, Chairman of the Drug, Chemical and Allied Trades Section of the New York Board of Trade, announced following a meeting of the Section's Executive Committee on January 14, that the 18th Annual Dinner of the organization would be held at the Waldorf-Astoria on Thursday, March 4, 1943.

Following the precedent set last year when the American Red Cross received a substantial contribution as the result of the Dinner, another war charity, to be selected shortly, will be the beneficiary of this year's contribution.

Arrangements are being made to present a speaker of national importance.

The price of the tickets will remain the same as last year—$10.00 per plate; tables of ten—$100.00.

• WATERPROOF BAG DEVELOPED

A new type of waterproof bag, in sizes never before manufactured in quantity for the protection of medical supplies and sensitive radio and electrical equipment during American landing operations in the North African campaign, was designed and developed by Quartermaster Corps technicians working with industrial experts, and manufactured in sufficient quantities for the campaign within a total period of two weeks, the War Department revealed recently.

The larger of the bags, which were manufactured in five sizes, measured 26 by 36 by 72 inches and was oblong in shape. It was made of a two-ply sateen fabric, bonded with rubber, and all seams were vulcanized. The open end was fitted with a "throat," 28 inches long which could be gathered up and tied.

Despite the excellent facilities of the plant where the bags were manufactured and the wholehearted cooperation of the management and employees, a number of production problems had to be overcome. A special rubber cement, for bonding the two plies of fabric, had to be developed and procured. Several of the employees developed an allergy to rubber cement and had to be replaced midway of the job. Owing to the size of the bags and the weight of equipment and materials they were designed to hold, it was necessary to attach rope grips or hauling tackle to them, and splice the ends of the ropes into one continuous strand on each bag to eliminate knots. This required teaching the art of rope-splicing to workmen in the plant.

For nearly two weeks, the facilities of the entire plant were put at the disposal of the Quartermaster Corps, with all commercial work shoved into the background. All employees worked long hours of overtime, but when the work finally got under way, it proceeded so smoothly that bags for the Army were being turned out on schedule and normal operation on commercial work could be partly resumed.

• PROMOTED AT WARWICK

Walter E. Murray, former Sales Manager of the Warwick Chemical Company at West Warwick, R. I., has been appointed Manager of the Textile Division and Vice President of Impregnole Corp., a subsidiary of the Warwick Chemical Co.

Mr. Murray's experience in his former position, and his many years in the textile industry, are sure to prove an adequate background for his new assignment.

• LAUNDERING HOSIERY

Laboratory tests conducted by the American Viscose Corporation, rayon producer, at its Textile Unit indicate that it is good practice for women to wash their rayon stockings before wearing them for the first time, the company made known recently. It is stated that such washing gives the high twist in the rayon yarn a chance to overcome the setting action which it gets in boarding. Furthermore, it is said to give considerably more whip or elasticity to the rayon fabric, with the result that the stockings fit better than if worn without being washed. Women should also know, the company states, that tests show there is an improvement in the elasticity of the stocking fabric with each successive washing, so that repeated washings definitely improve the fit.

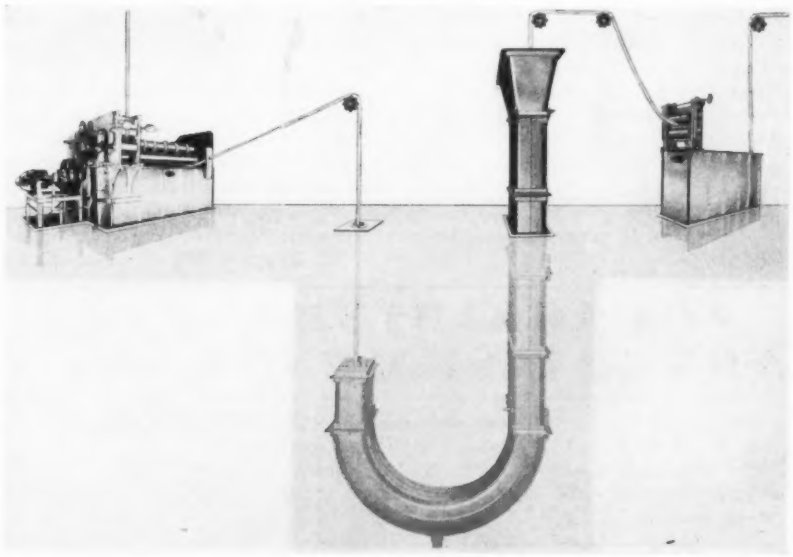
• DISTRIBUTION OF CHEMICALS

The War Production Board on January 15th made public the monthly distribution of chemicals for January under the allocation orders of the Chemicals Division. These chemicals amounted in value to $85,400,000 for the month, of which $56,400,000, or 66 per cent entered directly into identifiable military production. This is an annual rate of $1,024,800,000 for the total, and $676,800,000 for military. In addition, many derivative products of the 34 per cent

• CONTINUOUS PEROXIDE BLEACHING

A continuous process as shown at right, using special Rodney Hunt stainless steel equipment, has made the entire bleaching operation continuous at speeds said to be up to 150 yards a minute. The layout shown here was developed by the Buffalo Electro-Chemical Company using Rodney Hunt equipment.

The machine at the left is a Rodney Hunt "Slack Loop" Washer. In the center is a J-Box unit and at the right, a Rodney Hunt peroxide saturation unit. In operation, this unit takes the place of Kier bleaching. However, for a completely continuous process through the bleachery, two of these may be required.



not identified as direct military are necessary for the production of military items. The figure of $56,400,000 per month is, likewise, exclusive of military purchases of chemical material not under allocation, which are very large.

The allocated military chemicals are the essential raw materials for the production of all the explosives, propellants, war gases and other chemical combat items; aviation, Naval, Ordnance and Signal Corps insulation; special protective coatings for military vehicles and guns; and special paints for war and merchant ships. In addition, these chemicals include other materials indispensable to the construction of all types of aircraft and ships.

• SOLVAY CATALOG

A new 30-page "Solvay Products Book" has recently been issued. The book, the cover of which is in full color, is well organized for ready reference. It gives specific information on forms, and the chemical and physical properties of Solvay products and their uses which will be found economically useful by buyers and production men alike.

In addition to product information, there are short chapters on safety methods, on dissolving Caustic Soda and Caustic Potash and how to utilize Solvay Technical Service. The Solvay Products Book will be supplied on request by writing to Solvay Sales Corporation, 40 Rector Street, New York, N. Y.

• BULLETIN ON STAINS

A comprehensive study of stains and surface coloring has been prepared by William H. Peacock of the technical staff of the Calco Chemical Division, American Cyanamid Company, under the title, "The Formulation and Uses of Stains."

While this bulletin is prepared primarily for the paint and varnish trade, it is so extensive in its application that users of dyestuffs in all fields will find much of interest in its pages.

Copies have been prepared and will be made available to those who are interested on request to the Advertising Department, Calco Chemical Division, American Cyanamid Company.

• S.O.C.M.A. MEETING

The first general and regular monthly meeting of the Synthetic Organic Chemical Manufacturers Association for the new year was held at the Chemists' Club, New York City, on Wednesday, January 13th. The next meeting will be held on Wednesday, February 10th.

• CELANESE PATENTS

Two United States Letters Patent were granted this week to Celanese Corporation of America. Both patents, issued on application of W. Whitehead, relate to stiffened textile fabrics and their production.

The first patent, No. 2307178, is specifically directed to the production of a stiffening material for garments. According to this invention a fabric having a warp of a non-thermoplastic yarn, such as cotton, in admixture with thermoplastic yarn, such as cellulose acetate yarn, and a weft of natural horse hair is impregnated with a solution of a plasticizer for the thermoplastic yarn present.

The treated fabric is then dried and aged and then washed to remove the excess plasticizer and again dried and aged.

The second patent, No. 2307179, is specifically directed to the stiffened fabric produced by the process of the first patent. This fabric is eminently suitable for stiffening garments, such as coats and overcoats, because it can be firmly united to the garments by heat and pressure and because of its porosity and resiliency.

• OFFICERS, AMERICAN COUNCIL OF COMMERCIAL LABORATORIES

At the annual meeting of the American Council of Commercial Laboratories, held at Pittsburgh, Pa., the following officers were elected for the coming year: A. R. Ellis, President, Stevenson & Locust Sts., Pittsburgh, Pa.; Major W. P. Putnam, Vice Pres., 554 Bagley Avenue, Detroit, Mich.; B. L. Oser, Secretary, Food Research Labs., Inc. 48-14 33rd St., Long Island City, N. Y.; T. A. Wright, Treasurer, 47 Fulton St., New York, N. Y.

The Executive Committee, includes the officers and the following: G. J. Durant, 814 West Cary St., Richmond, Va.; H. L. Sherman, 246 Stuart St., Boston, Mass.; R. W. Truesdail, 520 W. Ave., 26, Los Angeles, Calif.; D. E. Douty, 1415 Park Ave., Hoboken, N. J.; M. L. Patzig, 2215 Ingersoll Ave., Des Moines, Iowa; A. J. Nydick, Executive Secretary, 63 Wall St., Room 1506, New York, N. Y.

The A.C.C.L. is composed of testing, inspection and research laboratories located throughout the United States. Most of the time at the meeting was spent in discussing the part that the laboratory members of the Council are playing in the War Effort and various committees were formed to correlate scientific work being performed by member laboratories and to direct it into Government channels, where it will be of the greatest help to the Armed Services.

• APPOINTED DIRECTOR, T.C.C.A.

At a recent meeting of the Board of Directors of The Textile Color Card Association, John F. Warner, Director of Development of the Calco Chemical Division of the American Cyanamid Company, was appointed a director of the Association by its president, Charles Pinnell, to fill the vacancy caused by the death of William Hand.

Before joining the Calco Chemical Company as vice-president in 1937, Mr. Warner was associated with the Pacific Mills in the management of their textile, printing and finishing plants and in the merchandising of their cotton and rayon piece goods.

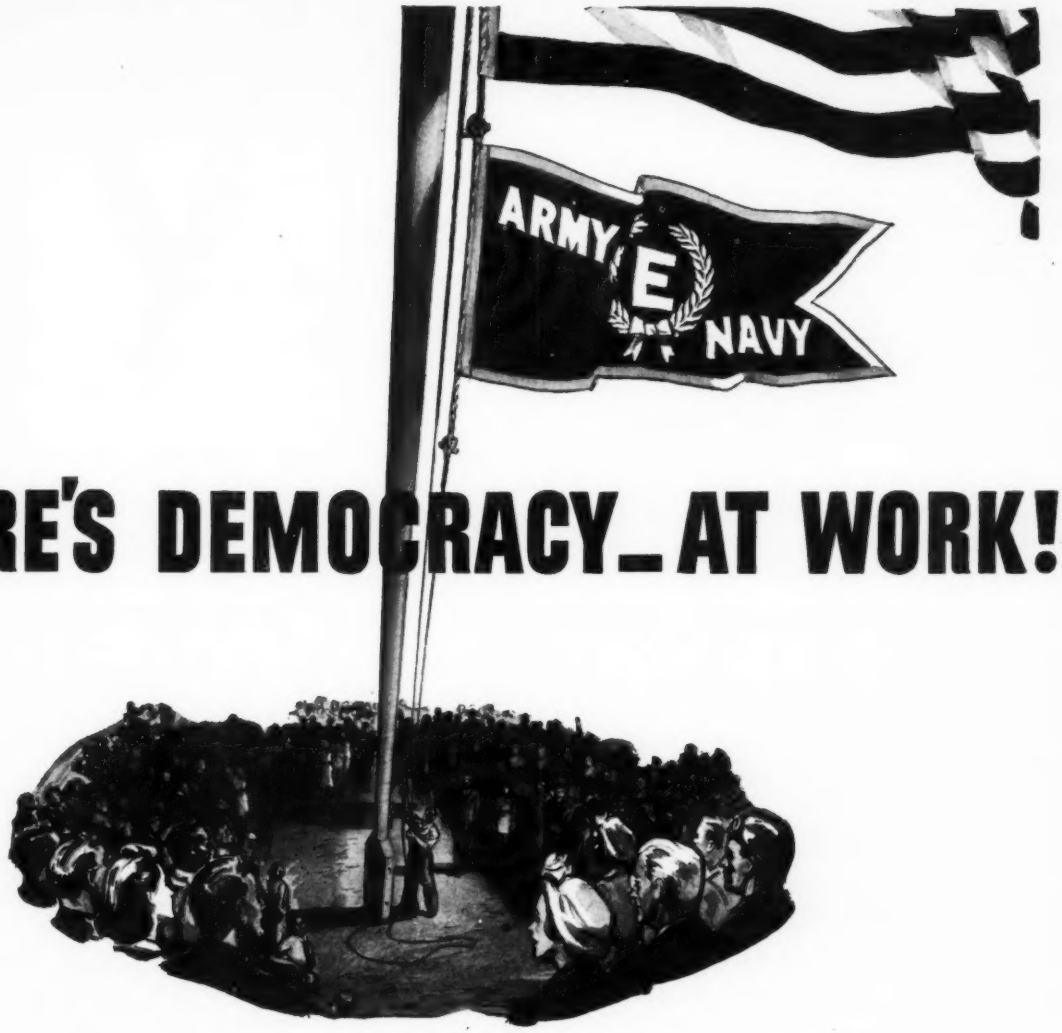
Mr. Warner is also a member of the Association's Dyestuff Advisory Committee, which was appointed immediately after the declaration of war by the United States, to advise the organization on all colors it will produce for the duration. This committee also serves as a link between the Association and the Dyestuffs Section of the War Production Board, whose Chief is Dr. Arnold Lippert.

In addition to Mr. Warner, the following now serve on the Association's Board of Directors: E. Irving Hanson, Sr., Stunzi Sons Silk Co.; Allan C. Jacobson, J. P. Stevens & Co.; Carl E. Kempf, Brewster Hat Co., Inc.; W. R. MacIntyre, Joseph Bancroft & Sons Co.; William B. Olmsted, American Viscose Co.; Brainerd Pidgeon, Stunzi Sons Silk Co.; Charles Pinnell, Merrimack Mfg. Co.; Armand Schwab, Armand Schwab & Co.; Alfred L. Simon, Alfred L. Simon & Co. and Roy E. Tilles, Gotham Hosiery Co., Inc.

• CLASSIFIED • ADVERTISEMENTS

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i.e., help wanted, machinery or supplies for sale—the rate is $6.25 per column inch or less per insertion.

POSITION WANTED: PRINT WORKS SUPT. Excellent references, experience extensive on all styles of machine printing on cotton and rayon fabrics, good production record, capable of satisfying the most exacting market requirements. First class colorist and processing man. Open for engagement after February 15. Write Box No. 418, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.



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It is the signal flag of democracy *at work*.

For it is one thing to promise deliveries on vital chemicals to the services. Another to draw up production schedules. And yet another to deliver the goods.

That accomplishment belongs to the workers in our plants. That accomplishment is the living proof of democracy *at work*.

It is solid testimony to the good will, cooperation, and loyalty existing here between the workers, the supervisors and the management of Calco.

And it is our tribute to those of us who have left temporarily to serve in the armed forces.

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AMERICAN CYANAMID COMPANY
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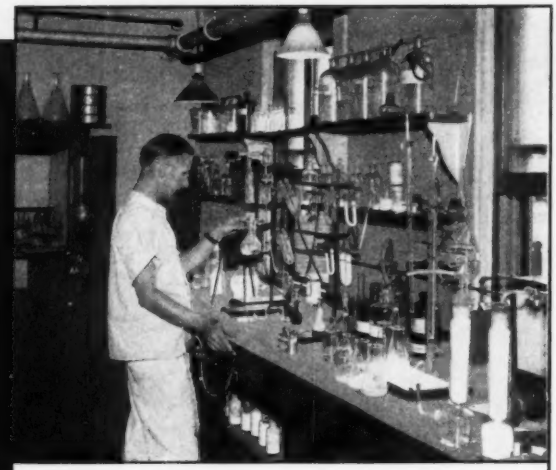

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for burlap and osnaburg for sand bags.

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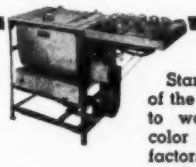

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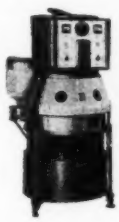

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The chemical needs of wartime industry now have first call on much of Cyanamid production. No one, we feel sure, would want this to be otherwise. But among the critical high priority materials are many upon which manufacturers of civilian goods have depended in the past.

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